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An Ontology of Socio-Cultural Time Expressions

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München, den 30. September 2004

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Abstract

The conception of time depends on the socio-cultural context; therefore there are variable understandings of the concept time. As a result, communication problems between people arise. In a dynamic and multi-cultural environment like the Web, where both billions of people with different socio-cultural contexts and numerous context dependent software applications interact, similar communication and inter-operability problems occur. Such problems can be avoided, if socio-cultural temporal information is described in an explicit, unambiguous and machine processable manner. This way, heterogeneous temporal Web application systems can share the same information, thus the same conception of time. In literature, Web ontologies are regarded as means to explicate knowledge and provide consensus about a given domain. This thesis first explores the domain of ontological engineering. Second, it devises the ontology, formalized in OWL, to explicate the conception of socio-cultural time. Expressions and concepts of socio-cultural time comprise the subject of the ontological model. This model is used to form the foundation of a socio-cultural calendar for the Web and to describe how a Web based automated appointment scheduling service provides more context sensitive service to its users, by deploying the ontological model and the socio-cultural Web calendar.

Zusammenfassung

Die Konzeption der Zeit hängt von dem sozio-kulturellen Kontext ab und ist deshalb unterschiedlich. Auf Grund dessen, Kommunikationsprobleme zwischen Individuen entstehen. In einer dynamischen und multi-kulturellen Umgebung wie das Web, wo sowohl Milliarden von Menschen mit unterschiedlichen sozio-kulturellen Hintergründen als auch zahlreiche kontextabhängige Computerprogramme interagieren, gleichartige Kommunikations- und Interoperabilitätsprobleme entstehen. Solche Probleme können vermieden werden, wenn das Wissen über die sozio-kulturelle Zeit explizit, unmissverständlich und maschinenlesbar beschrieben wird. Somit können heterogene temporale Websysteme die gleiche temporale Information, also die gleiche Zeitkonzeption teilen. In Literatur, Webontologien werden als Mittel betrachtet, um das Wissen über eine bestimmte Domäne explizit zu beschreiben und um darüber Konsens zu ermöglichen. Diese Magisterarbeit untersucht erstens das Gebiet Ontologiekonstruktion. Zweitens, expliziert sie, anhand der Ontologie formalisiert in OWL, die Konzeption der sozio-kulturellen Zeit. Die Ausdrücke und die Konzepte der sozio-kulturellen Zeit umfassen das Thema des ontologischen Modells. Dieses Modell, wird benutzt um die Grundlage eines sozio-kulturellen Webkalenders zu erstellen und um zu beschreiben wie ein automatisches Terminabsprachesystem für seine Benutzer mehr Kontext sensitiven Service bieten kann, wenn es das ontologische Modell und den sozio-kulturellen Webkalender benutzt.

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Appendix

1 Introduction

Time is ubiquitous, yet the conception of time is not necessarily absolute. In most cases people conceive of time on the basis of the culture and the society they live in. The Russian sociology professor Pitirim Sorokin defines the concept of *socio-cultural time* that exists independently of the concept of time as it is understood in natural science and that is necessarily culture dependent [82].

Consider the time concept ‘day’. How long is one day? Is it twenty four hours, is it as long as there is daylight outside, or is it so long as the working or school hours? The answers depend on our socio-cultural context. A day may be all those hours that a student has to spend at school or at the university, for a businessman a day can consist of the time at work, which can be a “successful day” or a “profitable day”, and for a patient, who needs to stay at the hospital “for one day”, a day is most probably twenty four hours. Merriam Webster’s dictionary defines eight such interpretations for the time concept of day. Now, consider ‘weekend’. In most western cultures weekend corresponds to the two consecutive days of Saturday and Sunday, whereas in most Middle Eastern cultures weekend is Friday and Saturday. Hence, there are at least two different ways how people conceive of weekend.

The socio-cultural context dependent conception of time, like many other conceptions, is implicitly present in people’s minds. That is, instead of being outspoken, it will be assumed that the others share the same conception. For example, when two citizens of a Middle Eastern country, say Israel, talk about weekend they take it for granted that Friday and Saturday is meant and understood. Yet, is it feasible to assume the same, when the Israeli citizen communicates with someone from a western culture?

Due to the modern technology of today’s world, interaction between people from different socio-cultural groups is very high. This means that more and more often people get confronted with situations like the one above, where they cannot afford to assume but they need to demonstrate knowledge about socio-cultural matters, such as the socio-cultural time.

The situation is identical within the context of the World Wide Web. Web is a dynamic system, where the concept of time is necessarily present and where billions of people interact with each other. Besides, everyday various software and application systems are being built for the Web. These application systems are developed on the basis of the context-specific needs and preferences of their developers and the intended users. As a result, the application systems carry the characteristics of their socio-cultural contexts, which differ in nature. Hence, when the application systems interact, problems of interoperability occur. Same applies to the handling of temporal information in Web application

systems. As seen, it is also determined by socio-cultural characteristics analogous to the case in the real world. Hence, inter-operability problems related to the representation of temporal information occur.

The problem of different modelling of same domains due to different understandings and perceptions and its consequent undesirable outcomes have been recognized by the Web community. Different Web applications concerning the same domain, say the domain of time, cannot cooperate because their temporal information is encoded using different terminology, languages and components that reflect their developers' conception of time. As we have seen, the conception usually depends on the socio-cultural context of the developers and of the intended users of the application. Ontology, which has wandered from the field of philosophy to the fields of AI and eventually to the fields related to the Web, is regarded in literature as the device to fight against the problem of clashing conceptions and terminologies [45],[46],[47],[49],[63],[66],[67],[68]. The idea behind is to define and advertise, in a formal and machine processable way, what an application system knows and how it conceives of one domain. On the basis of this information, application systems can be modified to become compatible with each other. Likewise, information about one domain can be defined by an ontology and it can be declared as the only way the information about the domain ought to look like. In other words it can be declared as the so-called *normative model* of the domain. Application systems that commit to this ontology automatically become inter-operable.

1.1 Motivation

Drawing upon the assumption of the existence of the socio-cultural time conception and of the consequent inter-operability problems within the context of the Web, we defend the idea that socio-cultural temporal information needs to be described for Web based temporal application systems. Yet, there are some requirements for such a description. It has to be formal, explicit, systematic and machine processable. Furthermore, it needs to be accessible to Web applications, so that diverse applications can commit to and share the same information. Clearly, ontologies fulfil all these requirements; therefore we have used the ontology as a device to describe machine processable knowledge about the domain of socio-cultural time for the Web.

During our research we have come across to numerous independent domain ontologies of time for the Web, e.g. [13],[39]. Culture ontologies cover the associated domain in its broadest sense, in that they provide models of cultural heritage systems [48],[21],[17],[78], of cultures in different enterprises and organisations [6], and of culture-specific language terms [7]. In doing so, these ontologies model the domain of culture and the domain of time as independent of each other. As we shall see, they do not touch the notion of socio-cultural

time. Additionally, we have not come across to any ontology of socio-cultural time that formally describes the socio-cultural conception of time.

Information about the conception of socio-cultural time can be captured by inspecting the expressions of socio-cultural time. In other words, it is possible to gain insight to the time conceptions of a culture or a social group by observing how their members talk about time. We will show the ways to represent this information by means of ontology.

Once information about socio-cultural time is formalized in a machine processable way, it can be used to support temporal Web application systems such as a Web based automated appointment scheduling service. We believe appointment scheduling is a task, where different conceptions of time can be frequently observed, when parties involved in appointment scheduling process come from different socio-cultural backgrounds. In [79] the characteristics of such a Web based automated appointment scheduling service is defined and it is stated that current Web based appointment scheduling services fall short in considering the notion of socio-cultural time. Being supported with this kind of temporal information, such services can react in a more sensitive way to their users' socio-cultural context dependent temporal needs and preferences. Additionally, on the basis of the socio-cultural temporal information defined in the ontology, socio-cultural calendars can be developed for individual use or as a component of a Web based automated appointment scheduling service. Clearly, this information can also be used for the semantic annotation of Web pages

1.2 Overview of the Thesis

The impetus of this thesis is twofold. First objective is to provide a brief introduction to the ontological engineering, which refers to the group of activities that involve the process of ontology development. Second objective is to present two ontologies we have developed that describe machine processable information about the domain of socio-cultural time related to nations, religions, business life & education.

Chapter 2 discusses the understanding of ontology in both disciplines of philosophy and computer science and it aims at a terminological clarification. The reasons why ontologies are necessary are discussed and some ontology kinds are introduced. Ontology development methodologies are mentioned, whereby one methodology, the METHONTOLOGY [3] comprises the focus. This methodology has also been used to develop the two ontologies in this thesis. Later, some well-known ontology languages such as the latest Web standard OWL [42] are briefly represented and some ontology development environments are mentioned.

Finally, the application areas of ontologies such as natural language processing, multiagent architectures and the vision of Semantic Web are referred to and three current ontologies are introduced. Chapter 2 concludes with the discussion of the provided information.

Chapter 3 provides an overview of the ontological models that exist in the domain of time and in the domain of culture within the context of the Web. As we have stated previously, we have not come across to domain ontologies about socio-cultural time, therefore we have turned our attention to ontologies about the separate domains of time and culture. The main intention of this chapter is to exhibit how the current ontologies of time and ontologies of culture address the socio-cultural conception of time.

Chapter 4 reports on the status of ontologies in the field of Natural Language Processing (NLP). We can acquire knowledge about the socio-cultural time by studying the natural language expressions that denote the concepts of socio-cultural time. To put it simply, we can learn about the socio-cultural context dependent conception of time by looking at the ways how people from different cultures and societies talk about time. Since we want to investigate the socio-cultural time expressions that comprise a subset of natural language expressions, we enter the field of NLP. Moreover, we want provide an ontological model of such expressions, therefore in Chapter 4 we discuss the views of NLP about modelling natural language expressions by means of ontologies.

Chapter 5, which comprises the core of the thesis, is devoted to describing the two machine processable ontologies we have developed to model socio-cultural temporal information for the Web. These ontologies are the Ontology of Socio-Cultural Time *Expressions* Related to Nations, Religions, Business Life & Education (henceforth Ontology of Socio-Cultural Time *Expressions*) and the Ontology of Socio-Cultural Time *Concepts* Related to Nations, Religions, Business Life & Education (henceforth Ontology of Socio-Cultural Time *Concepts*) As such, the former ontology provides a lexical model of the domain, whereas the latter a conceptual model. The two models are to be understood as complementary to each other. The details of this approach will be discussed in detail throughout the chapter. Subsequently, Chapter 5 clarifies the role of the Ontology of Socio-Cultural Time *Expressions* providing an overview of the syntactic and semantic structure of the ontology. As next, the development process of the Ontology of Socio-Cultural Time *Concepts* is described step by step w.r.t. the ontology development methodology METHONTOLOGY. Likewise, the syntactic and the semantic structure of the ontology is discussed. Chapter 5 concludes with the presentation of two concrete applications that use the ontology to provide socio-cultural temporal support for existing temporal Web applications. Furthermore, a use case, which describes a possible future application of the ontology is explained. We conclude our thesis in Chapter 6 by presenting the results of the thesis and by referring to the future work that necessarily arises from the obtained results.

2 State of the Art in Ontological Engineering

Ontology¹ is a term that appears in contexts as diverse as knowledge engineering [45],[52], knowledge representation [32],[64],[60], natural language processing [11],[12], database design [14],[15], information retrieval and extraction [62],[2],[33], knowledge management and organization [53] and multiagent systems [65],[38]. For a very long time, Ontology has been a subject matter to philosophy as a theory that is concerned with the nature of existence. More precisely, Ontology in philosophy describes what kinds of things exist in reality and explicates the relationships between the things existing in the reality [63].

In Artificial Intelligence (AI) ontologies have been used to explicitly declare the knowledge embedded in a knowledge-based system and to facilitate knowledge share and re-use. In multiagent systems ontologies describe the context of agents in which they interact with each other. Recently, the term ontology has started to get used more often within the context of the Web. As such, ontologies are understood as devices that bring a machine-readable conceptual structure to the Web, generating the *Semantic Web* [9],[47],[4].

Today, the Web is stated to have three major characteristics; first it has predominately a syntactic structure, second it is intended for human users and third it is a place to find things rather than to do things [68],[66]. Next step in the evolution of the Web is extending the Web with conceptual structuring or with meaning, so that it becomes a place to do things by using the so-called *intelligent Web agents*, so that it facilitates successful communication between humans and semantic inter-operability between software systems.

Providing meaning to Web has been considered as delivering an explicit description of the meaning of the documents found in the Web. More precisely, there should be references for the documents present on the Web that explain the meaning of the elements found in each Web document. Such references will be naturally located in the Web together with the associated Web documents. Thus, any application that has to do with a particular Web document can refer to its reference to *understand* the meaning of the document at hand. These references have to fulfil certain requirements in order to be understood by the application programs. The basic requirement is that the information contained in the references has to be explicit and well structured so that no ill-definitions or confusions exist. Given this picture, it has become clear that ontology could be a device to design the suggested references as it promises an explicit and unambiguous description and a common

¹In [49] Guarino and Giardetta distinguish between the term ‘Ontology’ (with the capital ‘O’) and ‘ontology’ (with the lowercase ‘o’). Accordingly, the former refers to the ontology in its philosophical sense and the latter to refers to its understanding and its use in AI. Henceforth, we will adapt the same convention and use ‘Ontology’ (with the capital ‘O’) only when we refer to the philosophical ontology.

understanding of any domain. Consequently, ontology was declared to be capable of bringing the necessary conceptual organization to the Web [4]. Since then, it has become an ever-growing research field, particularly within the context of the Web.

The goal of this chapter is to deliver a survey about the state of the art in ontological engineering. Ontological engineering refers to the group of activities that involve the process of ontology development [5].

In the first section, we will begin with the definition of ontology and we will clarify the understanding of Ontology in philosophy and ontology in computer science.

The second section deals with the question of why ontologies are necessary and it briefly discusses the related ideas of communication, inter-operability, re-usability and knowledge sharing.

Ontologies could be collected at least under three groups with respect to their purposes: first meta-level ontologies, second commonsense (or general) ontologies, and third domain-specific ontologies. Thus, the third section, Kinds of Ontologies, will discuss the characteristics of the three kinds of ontologies and will briefly introduce representative ontologies for each kind.

In the subsequent sections, we will mention methodologies for building ontologies as well as tools and languages that are used for developing ontologies. So, fourth section introduces an ontology development methodology called METHONTOLOGY [3].

In the fifth section some well-known ontology languages, such as KIF [29], CycL [57], RDFS [72] and OWL [42] are discussed.

Section six aims at familiarizing some ontology development environments focusing on the two ontology editors: OilEd from the University of Manchester, UK and Protégé 2000 from the University of Stanford, USA.

Section seven demonstrates the range of purposes ontologies may serve. These may be as diverse as applications on the Web and applications in multi-agent systems. Among them, we will outline three application areas for ontologies; natural language processing, multiagent architectures and the vision of Semantic Web. For each application area we mention the role of ontologies.

Section eight deliberates three ontologies by comparing and contrasting them depending on three dimensions; what is the ontology for, how is the hierarchy of the ontology organized and what are the applications in which the ontology is used.

Finally, in section nine we will conclude the brief survey about the state of the art in ontological engineering by a discussion that evaluates the current situation on the basis of the provided information.

2.1 What is Ontology?

Many definitions of the term ontology have been provided both in the field of philosophy and in the field of computer science, [31],[34],[5]. Yet, there has not always been consensus about the meaning of this term. In [34] Guarino reports that frequently similar ideas and issues are being addressed in different contexts and fields using different terminology and the term ontology is one of them. Accordingly, the idea behind the term *conceptual schema* used in data base community would be strongly similar to the idea behind the term ontology. In order to provide some terminological clarification, in this section we will have a closer look at various definitions of Ontology in the philosophical sense and the ontology in the computer science sense.

Ontology in its philosophical sense denotes the process of classification of entities in every area of reality [63]. The ontology in computer science, on the other hand, is understood as an abstract view of a part of the real world that is intended to be represented for computational purposes. The representation of this abstract view consists of the description of concepts and relationships that exist for that part of the world. As such, a computer science ontology is “*a specification of a conceptualization*” [31], and we will refer to this definition soon.

Considering the two definitions of the term ontology, three aspects seem to differentiate the understanding of the philosophical Ontology and the computer science ontology.

The first aspect concerns the representation of existence. From the point of view of philosophy, existence is what exists in every area of reality, whereas from the point of view of computer science, what exists is what you can represent.

The second aspect is about different purposes of the philosophical Ontology and the computer science ontology. The purpose of philosophical Ontology is to provide a complete description and explanation of all the goings-on in the universe. The computer science viewpoint on the other hand, says that it is impossible to represent the world in its entirety and in its full richness of detail. Thus, ontology in computer science has the purpose to provide the representation of a part of the world, so that it can be used to accomplish a certain task.

The last aspect is related to the function of philosophical Ontology. The philosophical Ontology is not understood as a device that could be used for a specific application; rather it acts as a reference to provide a better understanding of the reality and the existence. In computer science, however ontology is developed to be deployed for some concrete application.

So far we have discussed the use of the term Ontology in philosophy and the term ontology in computer science by comparing and contrasting their intended meanings in both

disciplines. In the following subsections we will discuss ontology as a subject matter of research in both disciplines. We start with the ontology in philosophy.

2.1.1 Ontology in Philosophy

Ontology as a branch of philosophy dates back to times of Aristotle's, who first worked out a theory of categories. Plato's theory of forms and Russell's theory of types are also considered as the earliest theories of Ontology [22]. There are many further definitions of ontology starting from early philosophers such as Gottfried Wilhelm Leibniz (1646-1716), who provides a rather enigmatic description of Ontology: "*Ontology or the science of something and of nothing, of being and not-being, of the thing and the mode of the thing, of substance and accident*" [1]. Christian Wolff (1679-1754), describes ontology as the first philosophy: "*That part of philosophy which treats of being in general and of the general affections of being is called ontology, or first philosophy*" [1].

More recent definitions of Ontology, like that of Guarino's, [34] seem to be more concentrated on a comparative view: "*In the philosophical sense, we may refer to an ontology as a particular system of categories accounting for a certain vision of the world. As such, this system does not depend on a particular language. On the other hand, in its most prevalent use in AI, an ontology refers to an engineering artefact, constituted by a specific vocabulary used to describe a certain reality*" [34].

Comparative definitions of the Ontology seem to have become more frequent, especially after the AI community turned its attention to Ontology. In [10], Smith and Welty explain the reason why that has happened. Accordingly, difficulties arose when different groups of data and knowledge-base system designers attempted to share, represent and reuse each other's frameworks and applications. Individual frameworks and applications have been built by each group using their own terms and concepts that correspond to their own needs and purposes without paying any specific account to the issue of compatibility. It is a fact that different knowledge- and databases employ identical terms for different applications and frameworks or same applications are referred to using different terms. In order to provide a solution to this incompatibility problem, computer science community referred to the Ontology. Thus, the philosophical Ontology has been applied to the context of computer science to provide a common vocabulary and a common understanding of the applications and frameworks about a given domain. In the following subsection we will more closely examine the ontology in computer science.

2.1.2 Ontology in Computer Science

As we have mentioned, Tom Gruber defines ontology as “*a specification of a conceptualization*” [31], whereby he explains a conceptualization as a collection of objects, concepts and other entities that are presumed to exist in some domain and that are tied together with some relationships. As such, a conceptualization for Gruber is a simplified view of the world, a way of thinking about some domain. As we engage with the world daily and as we involve in events, situations or happenings, we deal with such conceptualizations. The main concern of ontology in computer science is the question whether or not its own conceptualizations correspond to the conceptualizations of the real world [63].

An extended version of Gruber’s definition is provided by Fensel in [26], who says an ontology is a “*formal, explicit specification of a shared conceptualization*”. With this definition he brings about three further requirements, namely the explicitness, the formality and the condition of being shared. Accordingly, the conceptualization should be explicitly documented, it should be so formal that it is machine processable and finally it should be shared by a community so that there can be consensus about it. When application systems share an ontology, they are said to *commit* to that ontology and are expected to take actions, which are consistent with the definitions in the shared ontology.

Another definition views ontology as an *engineering artefact*, which is constituted by a specific vocabulary and by a set of explicit assumptions regarding the intended meaning of the vocabulary [49]. The vocabulary together with the assumptions should describe a certain reality. In the simplest case, an ontology is a hierarchy of concepts related by an *is-a* relationship, which is also known as *taxonomy*.

We conclude with Deborah Mc Guinness’ discussion about what can be considered as ontology in [47]. Accordingly, specifications that meet the following criteria can be considered as simple ontologies:

- has a finite controlled (extensible) vocabulary.
- there is a strict hierarchical subclass relationships between classes.
- has an unambiguous interpretation of classes and term relationships.

Following properties are considered to be typical but not mandatory:

- each class has property specifications.
- individuals are included in the ontology.
- each class has value restriction specifications.

Finally, the following properties may be desirable but not mandatory nor typical:

- disjoint classes are specified.
- arbitrary logical relationships between terms are specified such as inverse and part-whole relationships.
- each class has property specifications.

In this section we have discussed various definitions of ontology in two different disciplines of computer science and philosophy. We have compared and contrasted the understanding of 'Ontology' and 'ontology' in philosophy and in computer science, respectively. In the remainder of the thesis we will deal with the ontology in computer science.

2.2 Why Ontologies?

In this section we are going to discuss why there is a need for ontologies. Ontologies are thought to provide help in three areas at least; communication between humans, interoperability between heterogeneous computer systems and re-usability and knowledge sharing between these systems [45],[46].

Humans necessarily communicate with each other, yet it is not always straightforward. People, depending on their contexts and individualities, have different viewpoints and understandings of the same matters. It is not the case that every time they communicate they can also understand each other. Therefore, humans do need consensus about matters in order to succeed in communication.

Software applications are designed according to the context specific requirements of their developers and the intended users. They are coded in different languages, they consist of different software components and they use different terminology to describe their components. It is clear that heterogeneous software application systems need a mediator that facilitates their cooperation with each other.

Over and over methods and applications are being developed to solve the same problems and to accomplish the same tasks because existing solutions are unknown or they cannot be re-used. That causes loss of time, loss of effort and loss of resources. Therefore, a medium is needed to make existing solutions accessible to everyone in a re-usable format. Ontologies are considered as a step along the path of finding answers to these needs.

In the next subsections we will inspect, how ontologies try to accomplish this.

2.2.1 Communication

Humans can communicate successfully if they have a shared understanding or a shared viewpoint of some domain. Such a shared understanding can be achieved if the domain is described explicitly without conceptual and terminological confusion so that it can be understood in the same way by everyone. An ontology, in this respect, corresponds to such an explication.

Ontologies facilitate communication by providing an explicit specification of how a domain ought to look like, which is also referred as the normative model of a domain [45]. Moreover, ontologies guarantee consistency and lack of ambiguity concerning the description of knowledge about a given domain. As a result, confusions and misunderstandings become hard to take place.

A final aspect about how ontologies support communication between humans is that they can integrate different perspectives of the users. When users, who have different perspectives about one domain, share an ontology they have one standardised perspective of the domain. To sum up, we can state that ontologies facilitate human communication because they describe the normative model of a domain, they eliminate any possible misunderstandings and confusions about the domain and because they provide consensus regarding the domain for a community of people.

2.2.2 Inter-Operability between Systems

Inter-operability between systems refers to the extent, which different software application systems cooperate with each other. As we have mentioned previously, incompatibilities occur between different software application systems as a result of the fact that they have been built by different groups of system designers, who use their own terms and their own concepts depending on their contexts.

One of the initial approaches to handle such problems has been to provide *ad hoc* solutions. In other words, researchers have tried to find appropriate solutions each time an incompatibility occurred. However, as the amount of interaction between different systems increased due to the developing technology, researchers have come to a conclusion that an ultimate solution is needed that would deliver more effective results over trying to find solutions for every one incidence of incompatibility.

The ultimate solution has been envisioned as a single ontology, a so-called *backbone taxonomy* that unifies the underlying conceptual structure of heterogeneous computer and software systems [63]. This idea initially comprised the inter-operability approach. Yet,

within the course of time, it has been recognized that design of one ultimate ontology to unify all different computer and software systems would be a far too difficult task to accomplish. Moreover, it was not possible to determine the extent how far a single ontology would be adopted by a broad population of different computer science communities. Thus, inter-operability approach shifted its focus from the design of a backbone ontology to the exploration of integrative ways to support inter-operability.

According to the new direction, ontologies support inter-operability in various other ways than that provided by the one single ontology approach. One way is that the ontology can function as *interlingua* [45] between different systems. That is, they can be used to translate between different application languages and different representation schemes. When two application systems that have different conceptual structures or that are written in different languages need to interact, translations between the two systems become necessary. Moreover, these bi-directional translations need two separate processes. When more than two systems interact, the number of translations increase in due proportion. By deploying an ontology, the number of translations between different application systems can be reduced. In that case, each application would only need to translate its contents to the one language provided by the ontology instead of translating it to all the other languages of other applications and receiving all their translations.

The second way ontologies may facilitate inter-operability is the *knowledge integration* concerning different domains. In other words, with the objective of describing a unified domain or accomplishing a common task, an attempt can be made to integrate ontologies from different domains, each containing different kind of knowledge.

A final way how ontologies can support inter-operability is that they can integrate different vocabulary concerning same domains. That is, when several ontologies exist that describe the same domain using different vocabularies, these ontologies could be integrated by means of ontology integration methods to share the same vocabulary. Thus, different tools about the domain could commit to the integrated ontology and share one same vocabulary.

2.2.3 Knowledge Sharing and Re-usability

Knowledge sharing refers to the idea that when knowledge about some domain is formally described and documented, it can be made public so that others can also benefit from it [30],[40],[54],[52]. Re-usability and knowledge sharing can be achieved if knowledge components are explicitly specified and agreed upon by a community of agents. The idea behind the re-usability approach is that instead of developing from scratch, new computer and software applications should be built by assembling knowledge components that have already been built by others.

The purpose of such a practice is to decrease the high cost of software development and maintenance and to avoid loss of time.

Ontologies facilitate knowledge sharing and re-usability because they provide formal and explicit definitions of knowledge components that can be made public, for example on the Web, which can be shared with and reused by the others. The so-called *ontology library systems* can be used for these purposes. An ontology library system is an easily accessible system that offers various functions for managing, adapting and standardizing groups of ontologies [55],[69],[54],[67]. Thus, when an ontology is ready, it can be uploaded to an ontology library system, where a larger set of developers could have free access to it. If needed, developers may download the ontology from the library and re-use it for their own purposes. Ontolingua², WonderWeb,³ semWebCentral⁴, and DAML ontology library⁵ are examples of such ontology libraries for the Web. An extensive survey about Ontolingua and other current ontology libraries is available in [55].

Focus of this section has been on illuminating the reasons why ontologies are necessary. We have mentioned about major areas, where problems can occur when humans and different software application systems interact. These areas are communication between humans, interoperability between heterogeneous computer application systems and knowledge sharing and re-usability. Later, we have discussed how ontologies help overcoming the problems. To conclude, we summarize these issues. Ontologies support communication when humans agree on a specific ontology. In doing so, humans agree on only one interpretation of some domain, so that any possibility of confusion or misinterpretation is avoided. Ontologies support interoperability when heterogeneous computer application systems commit to an ontology. In that case, the ontology can act as an *interlingua* between those systems. Ontologies facilitate inter-operability also by facilitating knowledge integration and by preventing duplications of vocabularies. Finally, knowledge captured in ontologies can be shared and re-used, for example by uploading them to the ontology libraries on the Web.

2.3 Kinds of Ontologies

Ontologists and researchers of AI have distinguished between several kinds of ontologies that have been determined according to varying criteria. Among them three kinds of ontologies seem to be more representative. These are *meta-level ontologies*, *commonsense ontologies* and *domain ontologies*.

² <http://www.ksl.stanford.edu/software/ontolingua/>

³ <http://wonderweb.semanticweb.org/index.shtml>

⁴ <http://www.semwebcentral.org/>

⁵ <http://www.daml.org/ontologies/>

For Uschold, kinds of ontologies can be determined according to three dimensions “*under which the ontology is desired*” [67]. These dimensions are *formality*, the *purpose* and the *subject matter*. Consequently, an ontology can be *highly informal* by being defined in natural language, it can be *rigorously formal* by being written in a very formal language with formal semantics or it can be at a level in between.

An ontology may be *generic* or *less generic* in terms of its purpose. For example, ontologies representing very general knowledge such as commonsense knowledge are then considered to be generic. On the other end, ontologies that concentrate themselves on a particular application are less generic.

Finally, according to the subject matter an ontology can be a *domain* ontology, which describes knowledge about some specific area. It can be a *task* ontology, which is designed to deal with solving a specific problem or it can be a *meta-level* ontology, which describes information about data.

2.3.1 Meta-Level Ontologies

Meta-knowledge or *meta-data* is data about data [26]. Information about who has produced a given information, when it has been produced, in what format the information is and so forth, are all regarded as meta-data. As such, it is believed to be necessary for efficient access and intelligent management of data. For example, a library catalogue card can be considered as metadata; it contains data about the nature and the location of a book so it contains data and it is also data itself.

A *meta-level ontology*, also called *metadata ontology* is similar. It structures data and as such is itself data. *Dublin Core Meta-Level Ontology*⁶ is an example of a meta-level ontology. It is the outcome of an initiative that is prompted by the need for structuring data present on the Web. The purpose of the Dublin Core Meta-Level Ontology is to facilitate efficient search and efficient information retrieval despite the vast amount of information existing on the Web. Thus, Dublin Core Ontology attempts to organize the Web content by providing bibliographic information for the documents present on the Web. More precisely, Dublin Core Ontology defines some fifteen properties, which can be directly inserted into the HTML code of the Web pages in form of so-called *meta-tags*. Using meta-tags such as ‘Creator’, ‘Subject’ or ‘Title’, each Web document can be entered information that gives further information about its contents such as the related people, organizations, the creation time and date, subject matter and so forth.

⁶ <http://dublincore.org/>

2.3.2 Commonsense Ontologies

Merriam Webster's Dictionary defines two senses for commonsense knowledge: "*the unreflective opinions of ordinary people*" and "*sound and prudent but often unsophisticated judgement*". From AI point of view, commonsense knowledge is the one that is not explicitly stated but is implicitly present in humans' minds. For example, reading the sentence "*Mary saw the dog in the window. She wanted it*", we know by commonsense that *it* is the *dog* that Mary wants but not the window, although it is not explicitly stated [60].

Commonsense ontologies, also called upper, top-level or general ontologies, have the purpose to make such implicit knowledge explicit, so that it can be understood, shared and reused. The requirement for commonsense ontologies is that the knowledge they describe has to remain domain independent. That allows the construction of domain ontologies based on the domain-specific concepts in commonsense ontology [56].

Standard Upper Model Ontology SUO⁷ is one example of a commonsense ontology, which is an outcome of the collaborative efforts on creating a general-purpose formal ontology [70]. It is promoted by the IEEE Standard Upper Ontology working group, and it has been officially approved as an IEEE standard in December 2000. Parties taking place in the development of the process were representatives of government, academia, and industry from several countries. There are currently two versions of SUO: the IFF (Information Flow Framework) Foundation Ontology and the SUMO (Suggested Upper Merged Ontology). The purpose of SUMO is to create a comprehensive and consistent top-level ontology from some of the best public resources such as CNR's mereotopology group, other upper-level ontologies, time theories like that of James Allen's and others [5]. Another very well-known commonsense ontology is the Cyc⁸ ontology, which we will refer to in detail in the forthcoming sections.

2.3.3 Domain-Specific Ontologies

In literature, domain-specific or domain ontologies are defined as the declarative conceptualizations of terminology and knowledge in one domain [19]. The purpose of domain ontology is to facilitate the use of knowledge across different tasks and applications. That is, if knowledge about some domain is captured in a formal way in a domain ontology, then the knowledge can be easily accessed, distributed and reused just by publishing and deploying the ontology. There are two important criteria for the design of domain ontology. First one is that it should be designed in such a way that it can be integrated into a more general ontology when it is necessary. Second requirement is that it

⁷ <http://ontology.tekknowledge.com:8080/rsigma/arch.html>

⁸ <http://www.cyc.com/cyc-2-1/cover.html>

should be possible to integrate the domain ontology with another domain ontology to show how the two domains are related to each other.

Today, there is a vast variety of domain ontologies, most of which can be accessed by the ontology libraries we have mentioned previously. Linguistic ontologies, such as WordNet⁹ and SENSUS¹⁰, engineering ontologies such as EngMath Ontology¹¹, and enterprise ontologies such as the Enterprise Ontology¹² are examples of domain ontologies.

In this section we have mentioned about various kinds of ontologies that have been determined according to different criteria. We have introduced three kinds of ontologies, which are the meta-level ontologies, the commonsense ontologies and the domain ontologies and we have discussed their purposes. For each kind of ontology we have mentioned representative ontologies briefly.

2.4 Methodologies in Ontology Building

The existence of vast amount of ontologies developed by different groups with different approaches and techniques have brought about the issue that a systematics for constructing ontologies is necessary. Moreover, some researchers like Charlet *et al.* or Bench-Capon *et al.* have criticised the lack of an organization and the lack of standardized activities in ontological engineering and have defined the state of the art as being far from engineering but art [20],[37]. Consequently, some methodologies have been proposed to assist the process of ontology development. In this subsection we will have a brief overview of some existing methodologies, whereby we will focus on the METHONTOLOGY.

Most representative methodologies are known as Uschold and King's Enterprise Methodology [67] Grüninger and Fox's TOVE (Toronto Virtual Enterprise) methodology [43], and the METHONTOLOGY methodology [3]. Enterprise Methodology has emerged as an outcome of the experience of the two ontologists during the development of the Enterprise Ontology. In a similar way, the TOVE methodology has come into being during the construction of the TOVE ontology. Later, METHONTOLOGY was proposed as an official ontological engineering methodology. A comprehensive survey of these methodologies is provided in [27].

Goméz Pérez [71] lists some *general principles* that should be taken into consideration while developing an ontology. Some of these principles are (i) clarity and objectivity, (ii)

⁹ <http://www.cogsci.princeton.edu/~wn>

¹⁰ <http://mozart.isi.edu:8003/sensus2/>

¹¹ <http://www-ksl.stanford.edu/knowledge-sharing/papers/engmath.html>

¹² <http://www.aiai.ed.ac.uk/project/enterprise/enterprise/ontology.html>

completeness and coherence, (iii) maximum monotonic extendibility and (iv) ontological distinction. All these principles together say that the ontology should define the meaning of terms and provide complete definitions, it should deliver a natural language documentation, it should permit consistent inference and adding new knowledge to the ontology should not result in inconsistencies. Additionally, the ontology should make as few claims as possible about the world being modelled, that is, the ontology should not be over-specified. Finally, names in the ontology should be standardized wherever possible.

In most cases, the methodologies or ontology development approaches seem to have made their appearance from the experience of developing an ontology for some purpose related to a given domain like in the Enterprise or TOVE ontologies. Therefore, we assume they can provide good support when developing ontologies for similar purposes in similar domains. However, they may fall short in demonstrating the same efficiency for other purposes in other domains. METHONTOLOGY, however seems to constitute an exception, which has been developed as a stand-alone, domain independent methodology for ontological engineering purposes. Therefore, we will further investigate this methodology in the following section.

2.4.1 METHONTOLOGY

METHONTOLOGY is a “*well-structured methodology used to build ontologies from scratch*” [3] and it enables the construction of ontologies at the *knowledge level* [50]. It has been developed in Laboratory of Artificial Intelligence at the Polytechnic University of Madrid. METHONTOLOGY is supported by a software tool called Ontological Design Environment (ODE) and it consists of two processes called the **ontology development process** and the **ontology life cycle**.

The **ontology development process** consists of three sub-processes that run synchronously. First one is *management* and it involves activities about determining how much time and resources are needed for the construction of the ontology, about controlling whether the planned tasks are eventually completed and about verifying if the final results are satisfactory.

Second one is the *technical* sub-process. It consists of activities that are about the actual development of the ontology. These activities are *specification, conceptualization, formalization, implementation and maintenance*.

Specification activity states the purpose and the scope of the ontology. In other words, it states, why the ontology is being built, for what it will be used and who will use it. At the end of the specification activity a *Specification Document* is produced, which is in form of a table that summarizes the overall information about the ontology.

The *conceptualization activity* identifies the concepts, instances, relations and properties (attributes) related to the domain and it provides documentation. The conceptualization activity starts with the definition of a *Glossary of Terms*, which is a table consisting of a name and a description for each term that shows up in the domain of the ontology. Then *Concept Classification Trees* are built, where concepts of the domain are organized into taxonomies. After that, *Concept Dictionary* is defined based on the concepts organized in the concept classification trees. The *Concept Dictionary* is a table that consists of the meanings, attributes, instances of all concepts in the classification trees. Each instance of every concept in the concept dictionary is also listed in separate tables, which show the characteristics of the instances. At the end of the conceptualization activity, it is guaranteed that every sort of information that is present in the ontology is explicitly defined and written down so that it is clear what the ontology is exactly going to talk about.

As next, the whole information is *formalized* and *implemented* in a computational language. Finally *maintenance* activity concerns the continuous carrying out of knowledge acquisition, evaluation and documentation of the ontology.

Last part of the development process is the *support* sub-process, which as the name suggests, is about providing support to the management and technical sub-processes.

The second and the last process of METHONTOLOGY is the **ontology life cycle process**. As such, it is an ordering relation over each sub-process defined in the ontology development process. In other words, ontology life cycle process determines which sub-processes occur first and which activities are to be carried out primarily.

METHONTOLOGY seems to be a highly detailed and systematic methodology that provides clear-cut guidelines for the construction of ontologies. METHONTOLOGY has been adopted for the construction of, among others, the CHEMICALS, the Environmental Pollutants ontologies and the Reference-Ontology. [27] METHONTOLOGY has been recommended by the FIPA Foundation for Intelligent Physical Agents for the process ontology construction¹³.

In this section we have mentioned how methodologies for development of ontologies came about and have discussed several methodologies focusing on the METHONTOLOGY.

2.5 Languages for Writing Ontologies

Ontologies are formal theories about a specific domain; therefore they require a formal logical language to express them. Most languages for formalizing ontologies seem to have emerged based on two approaches; first-order predicate logic (FOL) and XML-RDF. In this

¹³ <http://www.fipa.org/>

section we will describe the ideas behind both approaches and mention their most representative languages. Concerning the first approach, we will examine KIF and CycL. Before we delve into the details of the following languages, we will provide an overview of XML and RDF as a language and a modelling structure, respectively. With regard to the second approach, we will look at RDFS and OWL. In doing so, most emphasis will be devoted to OWL¹⁴. This ontology language was proposed by World Wide Web Consortium (W3C) as the standard for developing Web-based ontologies, in February 2004.

2.5.1 First Order Predicate Based Languages: KIF and CycL

This subsection will discuss the ideas behind the development of KIF and CycL that are known as ontology languages. Both languages extend FOL by using second order concepts. FOL based knowledge representation languages have emerged from the ideas of a community of mathematicians and computer scientists, who wanted to define some expressive languages related to computer systems. Their motivation has been the shortfall of existing database or object-oriented languages in describing information in its highest generality. Their goal was to define such languages that are as expressive as natural languages but that do not suffer from imprecision or from ambiguity of the natural language. Thus, being persuaded by the expressivity and power of FOL, they set out for defining FOL based computer systems languages. KIF and CycL are languages that base themselves on this kind of approach. KIF initially was not designed as an ontology language but as a language for knowledge interchange. Yet, it is considered to qualify as an ontology language because of its high level of generality. CycL on the other hand, was developed as an ontology language in particular to represent the knowledge embedded in CYC common-sense ontology.

KIF (Knowledge Interchange Format) is a computer oriented language that was introduced by Genesereth and Fikes in 1992 [29]. It is designed as a knowledge exchange format between different computer systems to facilitate knowledge share. As such, it can be applied for the specification of ontologies, for software agent communication, for automated deduction and for constraint satisfaction. Typically, KIF works the following way: a program reads a knowledge base in KIF and it converts what it has read into its own internal implementation language. The program does all computation about the information using its own language. Later, when the program needs to communicate with another program, it maps its data that is in its own implementation language back into KIF. The communication partner this time translates the data from KIF into its own implementation language in a similar way. Thus KIF acts as an *interlingua* between different computer application systems.

¹⁴ <http://www.w3.org/2002/07/owl>

KIF specification identifies three major characteristics for the language. First, it has a declarative semantics i.e. the meaning of expressions in the representation language can be understood as is. Second, it is logically comprehensive i.e. any sentence in the first-order predicate calculus can be expressed. Third, it provides for the representation of knowledge about knowledge. Hence, users of the language can introduce new knowledge representation constructs without modifying the language. KIF language consists of constants, expressions, definitions and forms; a KIF knowledge base is a finite, unordered set of forms. Conjunctions, disjunctions, implications, equivalences and quantification can be defined in KIF using the appropriate operators. KIF extends FOL by using second order concepts such as reification (statement about a statement) of formulas as terms in other formulas.

CycL¹⁵ ontology representation language has been developed as a part of the Cyc project, which aims at constructing the largest knowledge base present to provide common-sense to computers. We will refer to Cyc in the forthcoming sections. As such, CycL is the medium of representing the Cyc ontology. Like KIF, CycL is also based on FOL and it also extends FOL by using some second-order features such as reification, equality, default reasoning, non-monotonic reasoning.

One specific aspect of CycL is the presence of so-called *microtheories*, which are also called *contexts*. They are Cyc constants denoting assertions, which are grouped together because they share a set of assumptions. Thus, a microtheory consists of assertions and each assertion must be explicitly stated to be true in at least one microtheory. An example of a microtheory in Cyc is the naive theory of physics (NTP), which says -using Cyc expressions- that if something is not supported it is going to fall [57]. As this theory cannot always hold (e.g. balloons, astronauts), microtheories in CycL come with additional specifications of when and where they should be applied. CycL extends FOL by allowing reification (predicates and formulas in CycL are treated as terms that can show up in other formulas) and by defining contexts to assert the truth of formulas.

2.5.2 XML and RDF Based: RDFS and OWL

XML [72] was developed to define a machine readable language that allows the syntactic structuring of documents. Therefore, XML cannot handle the issues concerning the semantics of the documents such as explicating the meaning of Web documents and providing terminological consensus on the Web.

Thus, researchers set out for developing languages that support semantics and that built on XML to benefit from its advantages such as the syntactic structure. RDFS and OWL

¹⁵ <http://www.cyc.com/doc/handbook/oe/02-the-syntax-of-cycl.html>

languages are outcomes of such an attempt. Both languages are based on **RDF** (Resource Description Framework), which is a data model developed for describing Web resources with metadata. As such RDF is not a language but a data model that is independent of any domain or implementation [9], [24].

As a data model RDF is graph based and it consists of nodes and edges. Nodes correspond to objects or *resources* and the edges correspond to *properties*. The labels on the nodes and on the edges are Uniform Resource Identifiers (URIs). Resources are all things being described by RDF expressions. A resource may be an HTML document, it can be a part of a Web page e.g. a specific HTML or XML element within the document source or it can be a collection of pages e.g. an entire Web site. Properties are specific attributes that describe resources and they have a defined meaning.

A property together with its value for a specific resource makes a *statement* about that resource. Statements consist of a specific resource together with a named property plus the value of that property for that resource. Thus, an RDF statement is a triple, whose parts are the *subject*, the *predicate*, and the *object*. The object of a statement, that is the property value, can be another resource, it can be a literal for example a resource specified by a URI, it can be a simple string or some other primitive datatype defined by XML. Reification is possible in RDF, so statements can be made about statements. A detailed documentation of RDF can be found at World Wide Web Consortium (W3C) RDF Primer [24]. As such, RDF itself does not define any primitives for creating ontologies, it provides basis for several other ontology definition languages such as RDFS.

RDF Schema or **RDFS** [72] has been developed in order to define the vocabulary used in RDF data models by specifying which kinds of properties apply to which kinds of objects, what values the objects can take and what kinds of relations between those objects exist. Therefore, RDFS is considered as a first move towards an ontology language for the Web.

RDFS offers a fix set of modelling primitives such as *rdfs:Class*, *rdf:Property* or the *rdfs:subClassOf* relationship to define RDF vocabularies for some specific application. In RDFS it is possible to define classes of classes, classes of properties, classes of literals that are strings, integers, booleans and so forth and classes of statements. Using RDFS properties, which are *rdf:type*, *rdfs:subClassOf* and *rdfs:subPropertyOf*, it is possible to define instanceOf relationship between resources and classes, subsumption relationship between classes and subsumption relationship between properties, respectively. Using *rdfs:domain* and *rdfs:range* properties it is possible to restrict the resources that can be subjects or objects of the property.

As we have mentioned, RDFS is regarded as only a first move towards an ontology language because it is considered to be not expressive enough to qualify as a full ontology language. There are a number of things that cannot be said in RDFS. For example, *disjoint*, *union*, *intersection* and *complement* classes cannot be defined, cardinality restrictions are not present and properties cannot be declared as *transitive*, *symmetric* or *inverse* of each other. Yet, researchers have determined that such features are essential for an ontology language if it is to provide efficient reasoning support. Therefore, they have set out for the development of a more expressive ontology language.

OWL (Web Ontology Language)¹⁶ has been developed with such a motivation. It is an outcome of the collaborative efforts of US American and European researchers, whose goal has been to develop an ontology language other than RDFS that can be commonly adopted and that will facilitate the semantic inter-operability on the Web. The Web Ontology Working Group of World Wide Web Consortium (W3C) describes OWL as “*a language designed for use by applications that need to process the content of information instead of just presenting information to humans*” [42].

Influences on OWL language has been, besides its predecessor DAML+OIL [18], Description Logics [23], the Frames paradigm and RDFS. As such, OWL language has three species: *OWL Full*, *OWL DL* (for Description Logics) and *OWL Lite*.

First language, *OWL Full*, is the most expressive of the three species. It is upward compatible with RDF, thus every valid OWL Full document is an RDF document. Yet, it is undecidable, therefore it is not possible to perform automated reasoning on OWL Full.

OWL DL, as the name suggests, is closely related to Description Logics and it constraints OWL Full with ideas from Description Logics. OWL DL is computationally complete and decidable, hence it is possible to automatically compute the classification hierarchy and check for inconsistencies in an OWL DL ontology.

OWL Lite is the least expressive sublanguage and its intended use concerns situations, where only a simple class hierarchy and simple constraints are needed. Yet, as a result of its restricted expressivity, OWL Lite can provide effective reasoning support. In [42] a detailed description of OWL and the characteristics of OWL ontologies are provided.

OWL ontologies have three components. These are *classes*, *individuals*, also called *instances*, and *properties*. In other formalisms properties are sometimes called as *roles*, *relations*, or *attributes*.

¹⁶<http://www.w3c.org/TR/owl-guide/>

OWL *classes* are interpreted as sets that contain individuals. Classes can be organised into a superclass-subclass hierarchy. When a class is declared to be the subclass of another, then every instance of the first class will also be the instance of the second one. In OWL DL, the superclass-subclass relationships can be computed automatically by an automatic inference mechanism. Classes can be declared to be *union*, *intersection* and *complement* classes. They can also be *equivalent* to each other. Finally, there are *enumerative* classes in OWL, which are classes that are defined by precisely listing the individuals that are the members of the class. Exactly these individuals make up the class. For example, the class *Kansas City Jazz Musicians* can be defined as being made up of exactly the members (the individuals) ‘Count Basie’ and ‘Dizzy Gillespie’.

OWL individuals are the objects of the domain that we are interested in. Referring to the example above ‘Count Basie’ and ‘Dizzy Gillespie’ are some of the individuals of our domain, say, the domain of Jazz Musicians. Further individuals could be then ‘Billy Holiday’, ‘Miles Davis’, ‘Thelonious Monk’, ‘Duke Ellington’ and so forth.

OWL *properties* are binary relations on individuals i.e. they link two individuals together. There are two types of properties in OWL. *Object Properties* relate objects to other objects like in ‘Chet Baker’ *plays Instrument* ‘Trumpet’. *Datatype Properties*, relate objects to datatype values. For example, ‘Chet Baker’ *died at the Age of* ‘59’. Like in RDFS, properties in OWL have also *domains* and *ranges*.

Similar to the case with classes, OWL properties may have *subproperties*, so that it is possible to form hierarchies of properties. For example, the property *is Jazz Musician* may have the more specific property *is West Coast Jazz Musician* as its subproperty.

Restrictions in OWL are the *quantifier* restrictions, the *has-value* restriction and the *cardinality* restrictions. The quantifier restrictions are declared using the two OWL constructs *owl:allValuesFrom* (semantically equivalent to the universal quantifier “ \forall ”) and the *owl:someValuesFrom* (semantically equivalent to the universal quantifier “ \exists ”). The has-value restriction is declared using the construct *owl:hasValue* (“ \ni ”). The *owl:hasValue* is a restriction on the value that some property can take by exactly specifying what that value is. For example, *is the city of Olympic Games 2004 owl:hasValue* “Athens”.

Using the cardinality restrictions on properties, we can describe the class of individuals that have at least “ $<$ ”, at most “ $>$ ” or exactly “ $=$ ” a specified number of relationships with other individuals or datatype values. Properties in OWL can be declared to be *transitive* like in *is Older than* property, they can be *symmetric* like in *is Married To* property or they can be *functional*, which states that a property has at most one value such as the property *age*.

One benefit of writing ontologies using OWL (more precisely OWL DL or OWL Lite) is that they can be processed by an inference mechanism i.e. by a reasoner. Thus, it is possible for a reasoner to check for subsumption relations in OWL ontologies and to compute the inferred class hierarchy. A reasoner can also check for consistency of OWL ontologies and can determine whether or not it is possible for a class to have any instances. At least two such reasoners, RACER¹⁷ and FaCT¹⁸ based on Description Logics, provide reasoning support for OWL ontologies. There are several future extensions that are being discussed for the OWL language such as enabling the definition of rules in OWL, which is currently not possible. Related research is being conducted [36].

Let us summarize this section. Throughout this section we have inspected four different ontology languages. Two of them are based on FOL, whereas the other two are based on XML and RDF. We have pointed out that the main distinction between the FOL based ontology languages and the XML based ontology languages seems to be that the former have not been developed with the specific purpose of applying them to the Web. KIF is an interchange format, which enables the exchange of information between different computer application systems and is general enough to qualify as an ontology language. CycL is an ontology language that has been developed to represent the Cyc commonsense ontology. Neither KIF nor CycL are specifically devoted to accomplish a task concerning the Web, whereas this has been the major concern of XML and RDF based ontology languages. RDFS and OWL are examples of such languages. They allow sharing ontologies on the Web. OWL has been declared as the latest standard for Web ontology languages.

2.6 Environments for Building Ontologies

In this section we will introduce two ontology editors that provide environments for convenient editing of ontologies. The first editor is Protégé 2000, which has been developed by Stanford's Medical Informatics Section in USA. The second editor is OilEd and it is developed by the Computer Science Department of the University of Manchester, UK.

There are many other ontology editors. We have decided to introduce these two editors out of three reasons. First both of them seem to be compatible with the latest standards in the field of ontological engineering. Protégé allows direct editing in OWL, whereas OilEd is capable of (partially) reading and saving in OWL. Both have a well developed import and export mechanism for OWL and for other recent ontology languages. Second, both editors are open source and can be freely obtained from the World Wide Web. Third, both of them can be used on various operating systems such as Windows and Unix/Linux.

¹⁷ <http://www.sts.tu-harburg.de/~r.f.moeller/racer/>

¹⁸ <http://www.cs.man.ac.uk/~horrocks/FaCT/>

2.6.1 Protégé 2000

Noy *et al.* in [51] define Protégé 2000 as “*a graphical tool for ontology editing and knowledge acquisition that we can adopt to enable conceptual modelling with new and evolving Semantic Web languages*”. Protégé is a computer program, which should be installed on the local computer and it can be downloaded as freeware from the Website of Protégé 2000¹⁹. It is available on different platforms like Windows, Mac OS, Solaris, Linux, Unix and its capabilities can be extended by downloading various plug-ins that are designed for the tool. Protégé 2000 can be used to construct a domain ontology, to customize knowledge acquisition user interface and to enter domain knowledge [44].

Classes (or concepts) of the domain to be modelled are visualized in a taxonomic hierarchy in Protégé. It is possible to define the instances of the model, so that for each class associated instances can be created directly in the model. The instances automatically become related to their classes by *instanceOf* relationship. Slots in Protégé describe properties of classes and instances. Facets specify constraints on allowed slot values. Axioms and rules cannot be explicitly represented, extra plug-ins need to be downloaded for these purposes.

Protégé does not allow synchronous editing of an ontology by multi-users, yet it is possible to import and export ontologies in different formats such as text files, database tables and RDF files. Since OWL has become standard ontology language for the Web, Protégé supports the editing of OWL ontologies by an OWL plug-in. This can be separately downloaded and be integrated into the editor. Thus primitives of the OWL language become available for use in Protégé to produce OWL ontologies.

The reasoner RACER provides reasoning support for Protégé. This tool can be separately downloaded to on the local computer. When it is run, it checks for the consistency of the ontologies created by Protégé and infers the classification tree of the ontology based on the subclass-superclass relationships. Several mailing lists such as *protégé-users*, *protégé-discussion*, *protégé-beta* exist that are really active and that are helpful for the developers. *The International Protégé Workshop* brings together researchers developing or using Protégé development methodologies and tools every year.

2.6.2 OILED

OilEd is a simple ontology editor that supports the construction of OIL-based ontologies [59]. Developers of OilEd admit that other ontology editors such as Protégé have influenced the design of the tool, whereby OilEd should put more emphasis on efficient

¹⁹ <http://protege.stanford.edu>

reasoning support. OilEd is a freeware computer program that can be downloaded and installed on the local computer²⁰. It is available at least on platforms such as Windows, Linux and Unix. Using OilEd, it is possible to create and edit ontologies, to check for the consistency and to infer the classification hierarchy of the ontology. Similar as in Protégé, it visualizes the classes of the domain in a taxonomic hierarchy and it allows the definition of instances in the model. Like in Protégé slots in OilEd describe properties of classes and instances. Facets impose constraints on allowed slot values.

Reasoning services for OilEd are currently provided by the FacT system, which is a Description Logics classifier. It tests the consistency of the ontology and infers the classification hierarchy w.r.t. subclass-superclass relationships. FacT reasoner, does not require a separate download as it comes with the editor itself. It can be installed on the local computer and can be connected to at some suitable timepoint to request the verification of the ontology at hand. The reasoner then checks for the consistency and infers the classification hierarchy.

OilEd does not provide support for working with multiple ontologies and it does not enable the migration and integration of ontologies. A mailing list called *oiled-discussion* also exists, however it is not as active as that of Protégé.

In this section, we have had a glimpse of two ontology editors Protégé from the Stanford University and OilEd from the University of Manchester. We have briefly discussed how they support the creation and editing of the ontologies for the Web and mentioned about their capabilities. We have provided the resources, where they can be found at.

2.7 Some Application Areas of Ontologies

So far we have considered what ontologies are, why we need ontologies, what kinds of ontologies exist and which languages and environments we can use to build ontologies. In this section we will inspect how the ontologies can be applied concretely. We will refer to three application areas of ontologies; first one concerns the Semantic Web Vision, second area is the natural language processing and the third area concerns multi-agent architectures.

2.7.1 The Semantic Web Vision

Lee, Lassila and Hendler define the Semantic Web vision as an extension to the current Web, in which information is given well-defined meaning, better enabling computers and people to work on [66]. As such, Semantic Web should be a place, where information can

²⁰ <http://oiled.man.ac.uk/>

be better discovered, can be automatically processed, can be integrated and shared across various applications. The precondition for the Semantic Web is viewed as providing the documents on today's Web with machine processable contents. In other words, Web documents should be furnished with information, whose context dependent meaning can be interpreted by software programs and applications.

According to Uschold's argument in [68], today's Web has a syntax that is defined through a huge a collection of HTML/XML mark-uped documents. It lacks meaning, commonsense, context and adaptability. Moreover, it requires human intervention. Uschold adds, however, that the Web is evolving from a place to find things to a place to do things such as the online-shopping activity.

There is a list of expectations from tomorrow's Semantic Web. Accordingly, it should understand the meaning and user background, it should enable inter-operability between heterogeneous applications and it should provide a platform for intelligent web agents and adaptive web systems to operate on. Eventually, it should require less human intervention. As such the ultimate goal set for Semantic Web is that it should assist human users in their daily on-line activities by exhibiting a higher level intelligence.

Ontologies should facilitate Semantic Web in various ways [9]. They can assist Web searches and they can interpret the retrieved information. We will refer to these issues related to natural language processing in the next subsection. Finally, ontologies are thought to be used for establishing communication between agents on the Semantic Web. As such a Semantic Web agent is considered as a software program that works autonomously. An example is Carnegie Mellon University's *Retsina Calendar Web Agent*²¹. It receives tasks and preferences from its user and sets out on the Web to find, to collect and to compare information to accomplish the tasks. It does this by communicating with other agents to profit from their information and their capabilities, where agents can reach a shared understanding among each other by exchanging their ontologies.

2.7.2 Natural Language Processing

Ontologies and natural language processing are referred together within the context of (Semantic) Web mostly to imply the quest for a more efficient Web search [9],[74]. Under more efficient Web search, the fulfilment of at least two requirements is understood. First one is that when we send out a query to the search engine, we want to retrieve the relevant documents as answers to our query and only the relevant documents. Second is that most desirably we would like to see only the relevant parts of the retrieved documents (instead of the entire document). In other words, we are only interested in the answers to our queries.

²¹ <http://www.daml.ri.cmu.edu/Cal/>

On today's Web, however, search looks quite different. First requirement is fulfilled but it is not satisfactory. Second requirement is far from being fulfilled. For example, even if the main relevant pages are retrieved for our query another thousands or may be hundreds of thousands of documents are also retrieved. It also happens that the query returns only a few relevant pages or none. Another common problem is that the query does not deliver the results we have expected because of different terminology. For example, the person who is looking for information about the jazz music group "Weather Report" may receive all kinds of pages containing weather forecasts, meteorological information, current weather conditions and so forth. The reason for these problems is associated with the insufficiency of keyword search because in most of the cases keywords in Web documents are considered to be too ambiguous to deliver relevant matches. Also, instead of the relevant answers, users retrieve whole documents as results of their queries, each of which needs to be gone through by the users to extract the information need [74].

Given this background, ontologies should help overcoming such Web problems by means of enabling the so-called *semantic annotation*. In [2] Kiryakov *et al.* define semantic annotation as "*a specific metadata generation and usage schema, aiming to enable new information access methods and to extend the existing ones.*" The idea behind semantic annotation is to assign the words, phrases or expressions present in the Web documents their semantic descriptions that interpret the meaning. More precisely, the so called *semantic tags*, whose meanings are precisely defined through concepts and relations in the ontology are to be attached to appropriate words, phrases or expressions in the Web documents to associate them with the meaning provided in the ontology. Hence, search engines can retrieve the Web documents according to the relevancy of this semantic mark-up. As the retrieval of the Web pages will be done on the basis of concepts instead of keywords, the problem of ambiguous keywords can be sidestepped.

2.7.3 Multiagent Architectures

In [65] Sycara defines multiagent architectures as "*systems in which many intelligent agents interact with each other. The agents are considered to be autonomous entities, such as software programs or robots. Their interactions can be either cooperative or selfish. That is, the agents can share a common goal (e.g. an ant colony), or they can pursue their own interests (as in the free market economy).*" In a nutshell, multiagent systems are systems that consist of a group of agents that work together to accomplish a common task such as executing a system.

DeLoach, DiLeo and Jacobs [38] state that ontologies in multiagent systems define the information domain of the system. The agents in the system interact with each other by passing messages. However, an agent can only make sense of a message if it has

information about the context of the message, in other words if the domain of the message is specified. Thus, ontologies specify the domain for the multiagent system to enable successful communication and efficient interaction between the agents. DeLoach, DiLeo and Jacobs add that an ontology is essential to guarantee the re-usability of the multiagent system because it specifies the view of the system on a given domain. Others, who want to reuse the constructed multiagent system, need to ensure that the ontology of the system complies with that of the new system.

Concrete use of the ontology in the multiagent system can be observed in the messages of its agents. Messages of the agents include references in form of attributes to the objects of the domain. The ontology defines the types of these objects so that each agent can perform the necessary reasoning. For example, when the sender agent triggers a message to the receiver agent referring to an object, say 'hole', the receiver agent can consult the system ontology and infer that 'hole' is an *obstacle* and can perform the appropriate behaviour.

This section has summarized some application areas of ontologies among many others. We have first briefly explained the Semantic Web Vision, which is considered the as the third generation Web. We have discussed the role of the ontologies toward the Semantic Web. As a second application area, we have referred to the field of natural language processing and have mentioned that ontologies are used in this context mainly to improve Web search. Finally, we have observed the application of ontologies in a context other than the Web, namely in multiagent architectures. After having cited the definition of these architectures, we have pointed out that ontologies in these systems are deployed to define the context of the system and to aid agent communication.

2.8 Examples of Ontologies

Here we will present some examples of the ontologies that are currently in use and that can be (partially) accessed via the Web. First ontology is the *Cyc* commonsense ontology, which is known as the largest knowledge database in the world that formally describes commonsense knowledge. Second ontology is the *WordNet* ontology that provides lexical reference for the English language. The third and the last ontology, we will discuss is the *EFGT Net*, which is a resource for systematic representation and organization of so-called *named entities*. The former ontology is a commonsense ontology, whereby the latter two ontologies are linguistically motivated. For each ontology we will mention its purpose, its hierarchical structure, the classification criteria, the properties and relations, some of its top level categories and its applications if provided.

2.8.1 CYC General Ontology of Common-Sense Knowledge

Doug Lenat, the founder of Cycorp²², has initiated the Cyc project in 1994 with the vision of creating the world's first true artificial intelligence that has both common sense and the ability to reason with it [57]. More precisely, the purpose of the project is to make common-sense knowledge accessible and processable for computer programs. As such, Cyc system consists of a very large ontology (of nearly two hundred thousand terms and several dozen assertions about each term), an inference engine, a representation language, a natural language processing subsystem as well as some other components. New knowledge is entered to Cyc both by human knowledge providers and by the system itself as a product of its inference process. A nice overview of Cyc system is provided in [61].

The ontology of Cyc knowledge base is centralized around the categories, also called classes or collections that are organized in a generalization-specialization hierarchy. The structure of the hierarchy corresponds to a directed graph allowing one category to have several direct generalizations i.e. supercategories. Categories have instances, which represent their members and that are specified along the *instanceOf* relationship.

The top level category of Cyc is the category *Thing*. It is partitioned and further subcategorized by following the so-called *distinctions* approach. Thus, the top level category has three partitions; *Individual Object* vs. *Collection*, *Represented Thing* vs. *Internal Machine Thing* and *Intangible* vs. *Tangible Object* vs. *Composite Tangible Intangible Object*. Each further category of the ontology must belong to one and only one of these partitions. New categories can be defined by combining the existing ones. Accordingly, entries such as "The Eiffel Tower" or "Billy Holiday" are assigned to the category of *Individual Object* and entries such as "Places To See" or "Jazz Singer" are assigned to category of *Collection*. *Internal Machine Thing* is the category of everything that is about the internal Cyc system such as strings, numbers and so forth. *Represented Thing* is everything else. *Intangible* is anything that has no mass such as numbers, *Tangible* is anything that has mass and energy e.g an animal. Finally, *Composite Tangible Intangible Object* is something that has both a physical and an intangible extend such as a particular person who has both a body and a soul.

OpenCyc²³ is the open source version of the Cyc ontology, which enables free access to the upper levels of the ontology. It can either be accessed and be browsed online or it can be downloaded on the local computer.

²² <http://www.cyc.com/>

²³ <http://www.openencyc.org>

2.8.2 WordNet Linguistic Ontology

The development of WordNet [74], which is known as an electronic lexical database, started in 1985 by the Cognitive Science Laboratory at Princeton University under the direction of Professor George A. Miller. WordNet can either be accessed and be browsed online, or it can be downloaded to use on the local computer freely. In the meantime, there are several systems that have integrated WordNet in their platforms to provide lexical reference support for their users e.g. the editor Protégé 2000. The OpenCyc is also linked to WordNet.

The objective of WordNet is twofold: first is to produce a combination of a dictionary and a thesaurus to facilitate more usability and second is to support automatic text analysis in artificial intelligence applications. The design of WordNet is inspired by current psycholinguistic theories of human lexical memory. It groups English nouns, verbs, and adjectives into sets of synonyms called *synsets*, and provides short definitions for them.

Synsets can also be considered as concepts in an ontology. For example, *{living thing, organism}*, *{person, human being}* and *{plant, flora}* are synsets that consist of nouns with similar meanings. If a word has more than one sense, it will show up in more than one synset. Synsets are related to each other through different semantic relations such as *hyponymy*, *hyperonymy*, *meronymy*, *familiarity* and so forth. *Hyperonymy-hyponymy* can also be seen as superclass-subclass relationship that organizes the synsets in a hierarchical order, whereby meronymy corresponds to the part-whole relationship.

As such WordNet is a taxonomy, so it does not have structured concepts or axioms that are typical for an ontology. In other words, concepts in the hierarchy of WordNet do not have any properties or attributes. For adjectives and verbs in WordNet there is another additional organization. Beside synonymy and familiarity relationships, synsets of adjectives are related to each other based on an *antonymy* relationship. For example, the synset of the adjective 'dry' is related to the synset of adjective 'wet' through the antonymy relationship. Synsets of verbs in WordNet are related to each other primarily by the *entailment* relationship. Hence, the verb 'walk' for example entails the verb 'step'.

The project EuroWordNet²⁴ has produced WordNets for several European languages including Dutch, Italian, Spanish, German, French, Czech and Estonian and linked them together, however these are not freely available. The Global Wordnet project attempts to coordinate the production and linking of WordNets for all languages.

²⁴ <http://www.hum.uva.nl/~ewn/>

2.8.3 EFGT Net Resource for Representing Named Entities

EFGT Net is a project initiated by Prof. Klaus U. Schulz, Levin Brunner and Felix Weigel at the Computational Linguistics Department of the University of Munich. As such EFGT Net [62] is a linguistically motivated ontology that has the purpose of representing formal knowledge about named entities and organizing them in a systematic way. Named entities are phrases that contain the names of persons, organizations, locations, times and quantities [75]. ‘Mount Ararat’, ‘Ella Fitzgerald’, ‘The Victorian Era’ are examples of such named entities.

With a systematic description and organization of named entities EFGT Net aims to provide support for semantic annotation, indexing, retrieval, querying of Web documents and text documents. EFGT Net is a free resource that is not yet publicly available and it covers three languages German, English and Bulgarian, whereas the primary language is German.

Named entities that appear in a document deliver a picture about the contents of the document and they usually simplify the understanding of the document. In order to be able to benefit from such information in automated document processing, the information embedded in named entities needs to be captured and explicated. Starting out with such motivation Schulz and Weigel describe in [62] a hierarchy for classifying named entities w.r.t. thematic-geographical-temporal relations.

The hierarchy of EFGT Net ontology is organized around so called *fields* or categories and *individual entities*. As such, a category refers to a set of entities, whereas an individual entity refers to one particular entity. There are four types of categories, which are the category of entities, the category of geographic areas, the category of temporal periods and the category of thematic field. There are three types of individual entities, which are the individual entity, the individual geographic areas and the individual temporal periods. Accordingly, *Novelists* would be an example of category of entities, ‘Emily Bronte’ an example of individual entity, Centuries an example of category of temporal periods and ‘17th cc.’ an example of an individual temporal period and so forth. Each entity and each category can be of one and only one of these types.

The structure of the hierarchy is a directed graph instead of a tree so that one category can have multiple parents. This way each named entity that belongs to a category can be found in the hierarchy starting out from different categories. For example [62], in order to reach the event ‘Olympic Games Munich 1972’ we can start from the category *Munich* and move down to the subcategories *History of Munich*, *Munich in the 1970s*, *Events in Munich in the 1970s*, *Sports Events in Munich in the 1970s* eventually arriving at ‘Olympic Games

Munich 1972”. Further paths leading to the event “Olympic Games Munich 1972” could start out from the category *Sports* or from the category *the 1970s*.

As seen, category combination is allowed in the EFGT Net ontology, thus new categories can be obtained by combining appropriate categories with each other in predefined ways. Both categories and individual entities have properties such as a main *name* that comes in all three languages, *synonym*, *ID*, *parents* and *ancestors* as well as *children* and *descendants*, *URLs*, *explanation* and so forth. The ID property furnishes each category and each individual entity with a unique identification number for organizational purposes. Parents, children, ancestors and descendants properties give information about subcategories and supercategories of the entities for navigational purposes, which can be followed up by the ID property. URLs property provides information about the related Web resources pointing out to the entities and explanation property provides textual data about each entity in natural language. Additionally, the entities in EFGT Net can be linked to the entities in other classification systems by means of various other properties.

Relations between the entities in EFGT Net include, besides the generalization-specialization and membership relationships, other relationships such as *overlaps*, *is_capital_of*, *is_the_of_in*, *is_location_of* and so forth.

The relationships can be of various arity between unary and quaternary. As such, these relations link categories and individual entities between and among each other. For example, *overlaps* relation link two geographical entities to each other such as in “Turkey” and “Europe” *overlap*. Other examples are “Washington D.C” *is_capital_of* “USA”, “San Francisco” *is-location-of* “Golden Gate Bridge” and “Princess Sylvia” *is_the* “Queen” of “Sweden” *in* “2004”.

Top level category of EFGT Net ontology includes subcategories such as *World*, *Politics*, *Finances*, *Sports*, *Organizations*, *Events* and so forth, each of which include further subcategories. Categories are determined based on encyclopaedic criteria and positioned in the hierarchy based on the combination of two approaches; the *analytical approach* and the *relevance based approach*.

According to the former approach, categories that have the same analytical status are introduced at the same branching level and depth. According to the latter, categories that are considered as more important are given precedence and defined in the higher levels of the hierarchy. For example, when classifying jazz music in Brazil two entities “Stan Getz” and “Antonio Carlos Jobim” are entered at the same level and depth to the hierarchy due to the analytical ordering because they are both jazz musicians.

Based on relevance ordering however, “Antonio Carlos Jobim” would have a higher position because he is a Brazilian jazz musician. Knowledge entry into EFGT Net is currently done by human knowledge providers but the authors point out to the need for semi-automatic methods.

Although other resources exist that have similar motivation such as WordNet, EuroWordNet or the Getty Thesaurus of Geographic Names²⁵, EFGT Net constitutes at least one distinction by concentrating on named entities. Additionally, most of these resources seem to focus on particular domains such as only geography or only linguistics, whereas EFGT Net aims at formalizing a wider spectrum of encyclopaedic knowledge. Moreover, work is being carried on to support EFGT Net with an inference engine that allows the automatic derivation of new knowledge from the EFGT Net knowledge base.

In this section we have referred to three examples of ontologies that are currently in use. For each ontology we have stated the motivation, we have discussed the classification hierarchy, the classification criteria, categories, properties, relations and individuals present in the ontologies. The three ontologies we have presented have different characteristics that distinguish them from each other. Although WordNet and EFGT Net are both linguistically motivated ontologies, they have different subject matters. WordNet is an ontology that has the function of a lexicon and a thesaurus, thus it is focused on words, phrases, collocations and their meanings.

EFGT Net on the other hand is focused on named entities that deliver encyclopaedic information. Cyc ontology is a part of the Cyc system that has the purpose of capturing and formalizing real world knowledge or commonsense knowledge for the use of computers.

2.9 Discussion

Ontology, having wandered from the field of philosophy to the fields of computer science as diverse as AI, Natural Language Processing, Database Systems and Multiagent Systems, is a popular research topic of recent times. As we have seen, there is a variety of definitions for the term ontology and there are different kinds of ontologies, which can be represented using a number of different languages. Ontology development process is in the mean time being considered as an engineering process, therefore methodologies and development tools exist to aid the process. Many ontologies are currently being used in various application areas.

²⁵ http://www.getty.edu/research/conducting_research/vocabularies/tgn/

Although there are many advocates of ontology in computer science [64],[68],[9],[9],[34], who see it as the precondition for knowledge sharing, for knowledge re-use and for the future success of the (Semantic Web), there are also critics of ontology [25],[28]. According to the view of the critics, ontologies do not suffice to guarantee knowledge sharing and re-use since these two practices would require also the sharing of inferences and rules and not only the sharing and re-use of declarative knowledge [25]. They believe this issue has not been taken into account by today's ontologists and ontologies. Other critical voices point out to the fact that a vast amount of ontologies exists, which use various ontology languages and which have different conceptualizations about the same domains, as a result of which there is still shortfall in common understanding and unity.

This difficulty has also been recognized by the ontology advocates themselves. That is why, the state of the art in ontological engineering is now focused on the so-called *ontology integration*. Ontology integration is a general term that is used to refer to several activities, such as *ontology combining, merging, aligning, mapping, translating, transforming* and so forth. More concretely, ontology integration corresponds to the process of finding the places in the ontologies, where they overlap, the process of linking the concepts that have related meanings with an equivalency relation and subclass-superclass relation and finally to the process of verifying the consistency of the outcome. A detailed discussion of numerous approaches to ontology integration is provided in [58]. All in all, ontology integration has the goal of bringing the related ontologies together to provide a unified view of a given domain and to facilitate the re-use of the existing ontologies.

On another level, ontologies as a classification device have been discussed in relation to *controlled vocabularies*, to *taxonomies* and to *thesauri* [76],[77].

A *controlled vocabulary* is a list of unambiguous terms that have been enumerated and defined explicitly. This list is controlled by a relevant registration authority. There are at least two requirements for a collection of list of terms to qualify as a controlled vocabulary. First, if the same term is commonly used to mean different concepts in different contexts, then its name needs to be explicitly stated to remove this ambiguity. Second, if multiple terms are used to mean the same thing, then one of the terms needs to be identified as the preferred term in the controlled vocabulary.

A *taxonomy* is a collection of controlled vocabulary terms organized into a hierarchical structure. Each term in a taxonomy is in one or more subclass-superclass relationships to other terms in the taxonomy. Subclass-superclass relationships can be of different types such as whole-part, type-instance relationships.

Thesauri take taxonomies and build upon them by allowing the definition of other kinds of relationships on top of subclass-superclass relationships. As described in ISO2788 standard, thesauri can be monolingual or as described in ISO5964, they can be multilingual. Some examples of the most important relationships in thesauri, which exist with the subclass-superclass relationships synchronously, are (according to ISO2788 standard) *synonymy*, *broader term* (i.e. the term higher in the hierarchy), *use* (i.e. a term, which is to be preferred over the current one), *top term* (i.e. the topmost ancestor of the current term), *related term* (i.e. not a synonym, not a broader or a narrower term of the current term but still related to it) and so forth. Thesauri are not necessarily controlled by a relevant registration authority.

A formal *ontology* is a taxonomy plus a collection of types i.e concepts, properties, relationships, instances and assertions about a domain of interest. It is expressed in an ontology representation language. Among all, ontology has the highest expressivity.

Finally, controlled vocabularies, taxonomies, thesauri and ontologies have the following aspects in common; they structure, classify, model, and represent the concepts and relationships about some subject matter of interest to some community. Additionally, they are intended to provide consensus about the subject matter to a community.

In conclusion, we can state that ontological engineering has been a popular research field during the recent years not only within the context of AI but also within the context of the Web. Especially, with regard to the vision of Semantic Web there are serious expectations from ontologies [66],[68],[9] as they promise a machine understandable description of knowledge and consensus about the knowledge. Nevertheless, there are several difficulties that the current state of the art of ontological engineering needs to overcome. Ontology construction is a time consuming and a high cost process. Therefore, (semi)automatic methods for ontology construction are being investigated [9] but these are far from being mature. Furthermore, currently there are considerably large numbers of ontologies in the Web that are in different languages and that have different conceptual structures. Therefore, ontology sharing and re-use seems to remain as a challenging task as long as successful integration of ontologies is not possible. However, due to current state in research, we still predict that ontologies' popularity will be increasing rather than decreasing in the near future.

3 State of the Art in Temporal and Cultural Ontologies

The aim of this chapter is twofold: First is to mention what kind of ontological models exist for the domain of time and for the domain of culture within the context of the Web. Second is to discuss whether socio-cultural time ontologies exist. If they do not exist, it shall be discussed how the current ontologies address socio-cultural conception of time. Here, we assume that a number of time and culture ontologies exist in the field of multiagent systems, yet we will concentrate on the Web ontologies.

During our research we have come across to numerous independent domain ontologies of time for the Web, which are in different ontology languages and which have different conceptual models e.g. [13],[39]. Simply sending the query ‘time ontology’ to the search engine Google returns a vast quantity of time ontologies. Additionally, as time is a general notion of reality like space, process, event and so forth, it has been modelled as a part of various commonsense ontologies such as the Cyc ontology and others.

Concerning culture, some ontologies exist that cover this domain in its broadest sense. Ontologies about cultural heritage systems [48],[21],[17],[78], ontologies about cultures in different enterprises and organisations [6], and ontologies about culture-specific language terms [7] are examples. Nevertheless, we have not come across to any ontology of socio-cultural time that formally describes the socio-cultural conception of time.

One of the most well-known ontologies about time is the *Time-DAML ontology*²⁶, which is named after the ontology language it is written in. As such, it is an outcome of the collaborative efforts of a number of researchers, whose motivation has been to develop an ontology to facilitate the adoption of a single representative ontology for the domain of time. The purpose of the Time-DAML ontology is to deliver formal temporal information about the contents of Web resources.

Very briefly, Time-DAML partitions the domain of time into two categories of time points and time intervals and defines relationships that hold between the time intervals based on Allen’s temporal interval calculus [8]. Defined time units include seconds, minutes, hours, days, months and years. Events are not described internally; instead some relations are defined to link the Time-DAML ontology to external ontologies that describe events [39]. The reason why we are mentioning Time-DAML ontology here is that we believe it falls short in terms of addressing the conception of socio-cultural time. Let us give an example from the Time-DAML reference to present the description of (socio-cultural) time concepts like *weekendday* and *weekday* in this ontology:

²⁶ <http://www.cs.rochester.edu/~ferguson/daml/>

An extract of Time-DAML ontology

```

<axiom id="4.3-12">
    weekday(y,x) <--> [Monday(y,x) v Tuesday(y,x) v Wednesday(y,x) v Thursday(y,x) v
                        Friday(y,x)]
</axiom>
<axiom id="4.3-13">
    weekendday(y,x) <--> [Saturday(y,x) v Sunday(y,x)]
</axiom>

```

Table 1

Definition of *weekday* and *weekendday* in Time-DAML ontology

According to this description, a *weekday* is defined in an enumerative manner to be one of the days of Monday, Tuesday, Wednesday, Thursday or Friday. In the same manner, the definition of *weekendday* concerns one of the two days of Saturday or Sunday. Although this definition may hold true for many cultures, it does not apply for a number of other cultures. For example, in Turkey, Friday may also be considered as a *weekendday*. Although Turkey officially uses the Gregorian calendar and the official weekend days are Saturday and Sunday, many observing Turkish businessmen do not work on Fridays and conceive of Friday as a *weekendday*. Yet another example is Israel, where Sunday is not a *weekendday* but it is the first *weekday*. Clearly, the current time model of Time-DAML does not refer to the culture-dependent conception of time.

Ontologies related to the domain of culture are not as high in number as the ontologies of time. Also, most of them concentrate on the domain of cultural heritage, in other words they model data related to museums. The ontology of *CIDOC Conceptual Reference Model* for cultural heritage systems is the most well-known ontology in this field [48]. It is a domain ontology that has an object-oriented model and that has the purpose to solve the problem of semantic inter-operability between museum data. In the ontology of *CIDOC Conceptual Reference Model* for cultural heritage systems, the concept of time is explicitly addressed. However, it is not related to the conception of socio-cultural time. Temporal information in *CIDOC* model is referred to by means of the categories *TemporalEntity* and *TimeSpan*. For example, "Impressionism" can be an example of a *TemporalEntity* and the time extent of "from 1867 to 1886" can be an example of *TimeSpan*. Then, by means of these and other primitives, it becomes possible to state the physical condition of a museum artefact, be it a painting, a piece of multi-media, a book or any other object, and its associated time period. A detailed illustration of the model can be found at [58]. However, this model is silent about the notion of socio-cultural time as it handles a completely different relation between culture and time, namely the associated time periods of the artefacts of cultural heritage.

Another ontology about culture is the one conceptualized by Abou-Zaeid in [6] and his ontology formally describes different cultural values within the context of international business enterprises. Drawing upon the assumption that today there are many international enterprises that work collaboratively over the borders, the purpose of his ontology is to build a shared vocabulary that explicitly specifies the similarities and differences between their value systems.

In short, Abou Zaeid's ontology is intended to facilitate the inter-cultural communication with regard to business enterprises. His cultural ontology focuses on *inter-organizational processes*, therefore the concept time is present in the ontology as an inseparable part of any process. However, as we have stated, the notion of socio-cultural time remains unaddressed. Otherwise, the cultural ontology defines two concepts that are *organizational-specific* values and relevant *national-specific values*. National-specific value is defined as “*a common value shared by people within a given country and can be used to distinguish one country's culture from another*” [6]. Although such a definition may be argued to contain the conception of time as a common value for a nation or a culture in a very general manner, there is no explicit reference to the perception of culture- or nation-specific time.

To conclude, we can state: as a result of our research, we have observed that separate domain ontologies model the notion of time and culture independently from each other. Additionally, culture seems to be a very loosely defined subject, therefore different ontologies model different interpretations of the concept culture. In the end, we have failed to find an ontology that handles the conception of socio-cultural time. Furthermore, we believe current time ontologies and culture ontologies fall short in addressing the notion of socio-cultural time.

4 Modelling Natural Language Expressions with Ontologies

In this chapter we will discuss the ontological approach at representing natural language expressions to reveal the underlying conceptual structure. Subsequently, we will refer to the status of ontologies in the field of Natural Language Processing (NLP) to mention the relationship that exists between the natural language and the ontology from the point of view of NLP.

Humans require words and expressions or at least symbols to talk about things in the world and to communicate efficiently. However, the mapping of words to things is only indirectly possible. It is done by creating concepts that refer to things. As Kuhn in [81] puts it nicely, “*meaning is about languages (in information systems or elsewhere), not about the world. Languages are about conceptualizations, and conceptualizations are about the world*”. However, meaning of an expression depends on how a speaker or listener understands the expression. This understanding, therefore the interpreted meaning, is strongly related to the socio-cultural context of the speakers and of the listeners.

Same situations and same things in the world can be conceptualized in multiple ways, which is the result of context dependent multiple understandings of same situations and things. This can be best observed by the expressions of natural language, which exhibit many forms of talking about the same phenomena. For example, “Beetle”, can have at least two different conceptualizations. First one is a particular type of insect and the second one is the famous car from the 70s. Ontologies, predominately domain ontologies, provide ways to explicate the conceptualizations behind the expressions of natural languages. In other words, from the point of view of NLP, ontologies are models about the meaning of expressions used in the languages. As such, they predict or prescribe the use of an expression to refer to a conceptualization of something in the world. Put another way, they reduce the one-to-many relationship between the language expressions and the concepts they denote, to a one-to-one relationship for a given language.

Given this relationship between the natural language and the concepts they denote, Bateman in [11] discusses how the relationship is considered in terms of ontological models. Accordingly, he distinguishes between three types of ontologies.

The first type of ontology assumes that there is no theoretical difference between the lexical information and the non-lexical information. That is, both expressions of natural language and the concepts they denote are treated the same way. To be more correct, in this type of ontology, lexical information is simply subordinated to the non-lexical information.

The second and the third types of ontologies do draw a distinction between lexical and non-lexical information. Accordingly, if the information is non-lexical and is related to psychology, then it is *conceptual*. If it is related to sociology, then it is *contextual*.

In [12] representatives for each type of ontology are introduced and discussed in detail, where it is also stated that the second and the third types of ontology have the most representatives and are suggested.

Bateman, who defends the co-existence of both lexical and conceptual levels, accounts for the third type of ontology. This is the one that distinguishes between the lexical and the conceptual information and that relates the conceptual information to the socio-cultural reality; *“But the commonsense world, where humans live is just as much, if not more, the world of social reality than it is the perceptual world of direct interaction and it is this socially-infused commonsense world for which accounts are necessary when more sophisticated behavior is to be explained or modelled”* and *“Each language and corresponding culture will have its own particular classes and combinations, its ways of giving meanings to the ground ontological attributes.”* Thus, Bateman defends the idea that the commonsense world and the associated conceptualizations go hand in hand with the social-reality, which are among others, reflected through the language of the associated culture.

John Sowa’s approach to the relationship between natural language and the conceptualizations is more towards the approach taken for the first type of ontology, therefore he has been heavily criticized by Bateman. John Sowa in [64] argues that languages, be it natural or artificial, are made up of symbols organized in well defined syntactic structures but the real world is made up of an endless variety of things. Therefore, it is not possible to capture the full richness of the world by means of languages. So, linguistic knowledge is subordinated to real world knowledge. However, there is still one point where Bateman and Sowa unite. That is, John Sowa also agrees that a language represents the concepts that exist in the environment and in the culture of the people who speak the language. Thus, the expressions of natural language about one domain deliver information about the underlying conceptual structure of the domain w.r.t. to some culture or society.

In [14] Madsen, Thomsen and Vikmar argue that natural language expressions themselves do not suffice to learn about the meaning as they merely lexicalize concepts. In order to understand the meaning we need to look at the conceptual structure that is lexicalized by the expressions. Yet, the relation between the conceptual structure and its linguistic representation is rather complex. As we have mentioned before, same expressions or same word forms may have multiple conceptualizations, which brings us into a state of ambiguity. Lenci in [41] identifies at least three reasons that give rise to ambiguities; (i) heterogeneous and implicitly structured nature of natural language, (ii) polysemy i.e. one word having multiple meanings and (iii) one word sense not clearly denoting the concept.

Let us look at a few examples. The concept Day, according to the Merriam Webster's Dictionary has eight different senses:

1. the time of light between one night and the next .
2. the period of rotation of a planet (as earth) or a moon on its axis.
3. the mean solar day of 24 hours beginning at mean midnight.
4. a specified day or date.
5. a specified time or period as in <grandfather's day>.
6. the conflict or contention of the day as in <played hard and won the day>.
7. the time established by usage or law for work, school, or business.
8. a period of existence or prominence of a person or thing.

One person, who uses the word "day", may refer to any one of the eight senses i.e. to the concepts listed above. In other words, one form at the linguistic or lexical level maps into many different concepts at the conceptual level.

Now that we know there are multiple conceptualizations of same matters as a result of the associated social-context, that there are multiple word forms, which denote those conceptualizations and that we know only looking at the expressions does not suffice to understand the conceptualizations, we need to confront the question of how to represent the expressions by means of an ontology. In our case, how are we going to represent socio-cultural time expressions related to nations, religions, business life & education by means of an ontology? As we have seen, there are two different approaches. According to the first one, we can subordinate the socio-cultural time expressions to socio-cultural time concepts i.e. we can subordinate the lexical level to the conceptual level. The other approach is to distinguish between the socio-cultural time expressions and the socio-cultural concepts, i.e. to distinguish between the conceptual and the lexical level, to accept that they co-exist and to create the ontological model accordingly.

Following the first approach, a single ontology would suffice to model the domain. Second approach, however would require two ontologies to treat the two levels appropriately. In our regard, the second approach would deliver a more accountable model of the domain and it is also the suggested approach as we have seen. Hence, the first ontology, which refers to the lexical level, models the expressions of socio-cultural time that denote the concepts of socio-cultural time. Thus, the first ontology, although it refers to the meaning to a certain extent, does not unambiguously and precisely describe the meaning. Rather, it demonstrates the use of the socio-cultural time expressions in the natural language, thereby represents their ambiguity.

Second ontology, models the concepts denoted. Therefore, it does provide an explicit and unambiguous description of the meaning, in that it predicts or prescribes the use of the

expression to refer to a conceptualization of something in the world. In other words, the second ontology at the conceptual level determines an interpretation (or a fixed meaning) for the expression. Consequently, the syntactic structure of both ontologies remains similar, whereby the semantic structure is different. In the ontology at the lexical level the expressions are necessarily assigned to multiple categories to exhibit the ambiguity. In the ontology at the conceptual level this is strictly avoided to describe the meaning precisely. Furthermore, only the ontology at the conceptual level can include binary relationships such as *subordinate Concept* or *superordinate Concept*, as these relationships explicitly refer to concepts i.e. to the meaning.

Finally, such an ontological model would not be a linguistically motivated ontological model. To be linguistically motivated, the purpose of the ontology would have been to explicate the relations between all the lexical forms (words, phrases, collocations etc.) of a given language and all the concepts that each one lexical form denotes. Such an ontology would then represent, for example, the word “day” and all the concepts it denotes i.e. all of the eight senses listed above. Then, it would relate the word “day” to each one of these senses by using semantic relations, for example *has Wordsense*, *synonym* *antonym* etc. WordNet, as mentioned afore, is an example of an ontology, which has this kind of purpose for the English language. The purpose of the ontological model we have described is rather to provide consensus about a given domain by laying down or prescribing one interpretation of a given lexical form among many others. In our regard most domain ontologies follow this principle. For example, a domain ontology about financing would most probably determine the interpretation of “bank” as a financial institute, whereas a domain ontology about carpentry would determine the interpretation of the same word as a piece of (wooden) furniture.

Let us summarize all the issues discussed. Humans require words and expressions to communicate and they do this by creating concepts, which refer to things and which are denoted by the expressions. The creation of concepts is highly dependent on the socio-cultural context in which one person lives. Therefore, there can be multiple conceptualizations. Moreover, some expressions may denote multiple concepts. Domain ontologies provide ways to explicate the conceptualizations behind the expressions of natural languages. They do this by predicting or prescribing the use of an expression to refer to a conceptualization of something in the world. Linguistically motivated ontologies list all the expressions and all the concepts they denote and they function as lexical references. From the NLP point of view, there are three types of ontologies, which deal with the situation. The first type does not distinguish between concepts and expressions and assumes that the former is subsumed by the latter. The second and the third types do distinguish between expressions and concepts or expressions and concepts that depend on contexts.

Views agree that only by looking at the expressions, it is not possible to explicate the meaning, this requires a conceptual level.

Consequently, the third type of ontology, which has the approach of partitioning the domain into a lexical and a conceptual level, is the suggested approach. Finally, we consider this is as the appropriate approach for modelling socio-cultural time expressions related to nations, religions, business life & education as most of these expressions denote multiple concepts, therefore they do require a conceptual level. This way, we can explicate the meaning and lay down an interpretation to avoid ambiguities concerning the domain. However, the lexical level is also necessary as the expressions of socio-cultural time deliver information about the concepts of socio-cultural time, even though the expressions themselves do not precisely and unambiguously explicate the meaning.

This chapter has discussed the NLP viewpoint for representing knowledge about real world by means of ontologies. One point has been the relationship between the conceptual structure of real world knowledge and its representation in the natural language. The second point has been how different ontological approaches consider this relationship. The opinions about conceptual structure of the real world being revealed in the expressions of natural language have also been discussed. We have mentioned the problems about natural language expressions denoting more than one concept.

5 **Ontology of Socio-Cultural Time *Expressions* and Ontology of Socio-Cultural Time *Concepts* Related to Nations, Religions, Business Life & Education for the Web**

In this chapter we will first recall the motivation behind the task of unambiguous, systematic and machine-processable explication of knowledge about socio-cultural time that is related to nations, religions and business life & education. Then, we will discuss our proposal that encourages devising two separate domain-specific ontologies to accomplish this task. We will justify the need for two ontologies, clarify their position with respect to each other and focus on one. We will define the role of the first ontology, which is the Ontology of Socio-Cultural Time *Expressions*. We will proceed with stating the purpose and the scope of the second ontology, which is the Ontology of Socio-Cultural Time *Concepts*. We will go into the details of this ontology as it comprises the focal point. Finally, we will show the realized and possible applications that use the focal ontology. We start with the definition of socio-cultural time.

The Russian sociology professor Pitirim Sorokin was the first person to mention about socio-cultural time in his book “Socio -Cultural Causality, Space, Time” [82]. Here, Sorokin argues that the way a specific culture conceives of causality, space, and time is not the same as natural science conceptions and must be understood in relation to the specific socio-cultural context. Consequently, he suggests there are two different conceptions of time. One is as we understand it in natural science. Second conception on the other hand, exists independently of the first one and it is necessarily culture dependent. Sorokin defines the second conception of time as *socio-cultural time*.

“Within the same territorial aggregate composed of different religious, occupational, economic, national, and cultural groups, there are different rhythms and pulsations, and therefore different calendars and different conventions for the sociocultural time of these groups. Compare a Harvard calendar with one operating, say, among factory workers. The calendar of the Roman Catholics in Boston—in part, at least—is different from that of the Protestant Bostonians. Side by side with quantitative time (which itself is in a degree a social convention), there exists a full-blooded sociocultural time, with all its ‘earmarks’: it is qualitative, it is not infinitely divisible, it does not flow on evenly; it is determined by social conditions, and reflects the rhythms and pulsations of the social life of a given group”

Different social groups and different cultures have different conceptions of time, as a result of which complexities arise. Let us return to our example with the weekend; in most western cultures the expression “Weekend” is used to refer to the two consecutive days of Saturday and Sunday w.r.t. the Gregorian calendar.

In our regard, such use of the expression “Weekend” refers to the time period of two days that are reserved for leisure time, when one in most of the cases does not have to work (we acknowledge that there are exceptions such as museum workers, healthcare workers, sales personals etc, who work on the “Weekend”). The expression “Weekend” in Islamic and Jewish cultures though, refers to the two consecutive days that are again associated with leisure time and with exemption of work, but this time the two days are Friday and Saturday.

Clearly, the conception of time underlying the expression “Weekend” is different in the related cultures. In one culture, it denotes the concept of a time period that corresponds to the 5th and 6th days of a week w.r.t. the Gregorian calendar and in the other culture it corresponds to the 6th and 7th days of the week. Hence, in Israel or in Turkey²⁷ there is a different time conception of Weekend than that of in Germany. It could be helpful to acknowledge this fact when scheduling appointments ‘for the weekend’. Let us consider another example, the concept of Summer Semester in higher education. In Turkey, there is not a concept of Summer Semester because summers are too hot to allow any form of study or lecture. Instead, the Academic Year is partitioned into two semesters, which are the First Semester and the Second Semester. The Second Semester ends around the middle of June before the hot summer time starts. Now a German student, who has done all his plans according to doing an exchange semester in Turkey during summer, would be surprised to find out in the end that this is not possible at all. In the Turkish culture, there is no such concept as Summer Semester. Similarly, a Turkish student, who wants to have an exchange semester in Germany may sit and wait the summer to be over to be able to start studying, whereby wasting a lot of time.

Due to the rapid developing technology, today the interaction between people from different socio-cultural contexts is very high. However, different people may have different conceptions about the real world and a reason for this is the different socio-cultural contexts that the people belong to. Such conceptions are implicitly present in people’s minds. In most cases, each socio-cultural group takes its conception of a matter as a benchmark and assumes that the members of the other socio-cultural group would share the same conception. As Sorokin points out and as the above examples illustrate, same is the case with the conception of time.

False assumptions as above and the consequent communication problems could be avoided if the implicit conceptions of time are made explicit and shared with others. In the real world there are books, workshops, courses, seminars and even departments at universities

²⁷ In Turkey weekend is officially composed of Saturday and Sunday. However, observing Muslims start their weekend on Friday, which is the holy day of the week according to Islam during which one is exempt from work.

such as intercultural communication or cross-cultural communication that are aimed at capturing such knowledge, making it explicit and sharing it with others.

In this thesis, we assume that in a multi-cultural environment such as the Web, where the interaction between people from different socio-cultural contexts and the interaction between the Web application systems developed by them according to their context specific needs are extremely high, complexities similar to those in the real world arise. That is, communication and cooperation problems due to the lack of understanding and recognizing the different conceptions of time. Therefore, we believe in the need for explicitly defining knowledge about socio-cultural time for the Web, just like the books, courses and lecturers do it for the real world.

Starting out with this motivation, we have defined our task as providing a formal, explicit, unambiguous and systematic description of knowledge about socio-cultural time related to nations, religions and business life and education for the Web. Our goal is to support temporal Web application systems such as automated appointment schedulers with socio-cultural conception of time, so that they can react in a more sensitive way to the users' culture specific needs and expectations. During our research we have not come across to a formal and machine processable description of this kind of temporal information for the Web.

We believe appointment scheduling is a task, where different conceptions of time can be observed frequently and where they play an important role. In [79] Spranger describes the characteristics of such a Web based appointment scheduling system by means of scenarios, provides examples of some currently used schedulers and illustrates the system's global structure. Furthermore, she points out to the fact that the scheduling systems in question "*are mostly limited to one calendar system and a particular representation scheme*". So, they do not consider the socio-cultural conception of time.

Let us reconsider the two examples above within the context of the Web and assume that scheduling an appointment for the weekend and searching for an appropriate exchange semester in summer are done by temporal Web applications such as automated appointment schedulers and automated student exchange finders that do not require human intervention.

Clearly, such an application needs the same information as humans, namely the information about socio-cultural time. Only then it can reason that weekend as a concept is not absolute but it is relative to a given culture, that the concept of Summer Semester cannot be found in every culture and that Turkey is one such culture and so forth.

Given this picture, there are at least two requirements for a temporal Web application system such as the automated appointment scheduler to be able to make use of the knowledge about socio-cultural time. First, the knowledge should be defined in a very formal, explicit and unambiguous way, in other words it should be formal enough to be machine processable. Second, it should be accessible to the Web application system. Ontology fulfils both requirements; it provides unambiguous, formal and machine processable description of any domain and it is accessible to any Web application system once it is published on the Web. Therefore, a domain ontology that formally describes the socio-cultural time can help overcoming communication and cooperation problems on the Web that can arise due to differing time conception of heterogeneous cultures and social groups.

The domain of socio-cultural time is very broad as it covers the time conception of every culture and every social group. In [79] Spranger provides a hierarchical structuring of the domain of socio-cultural time. In other words, she demonstrates how general and how specific a time conception can be, based on socio-cultural characteristics. Accordingly, the top-level category is a universal calendar system that is adopted by a large group of cultures and social groups. At the lower levels there are calendar systems, which are based on time conceptions of countries, states, regions, business enterprises and academic institutions. Finally, the lowest level representing the most specific calendar system, is the one from an individual person reflecting own socio-cultural conception of time based on own social context and individual specifications.

In this thesis, we restrict the domain to a subset of socio-cultural time that is related to nations, religions and business life & education. There are two reasons for deciding for these socio-cultural groups; first we believe that in real life knowledge about socio-cultural time is very often embedded in these particular socio-cultural groups. Second, we predict Web applications such as automated appointment schedulers that this ontology aims to support, would be most appealing to the specific social group of business people and academia of different nations and religions.

Within this context, we have paid specific attention to the Turkish, US American and Israeli nations, the Islamic, Christian and Jewish religions and the social groups of secondary and higher education as well as the group of business people. In our regard, Islam, Christianity and Judaism represent three most widespread religions of the world, Turkish, US American and Israeli nations represent three considerably big nations, which are also mainly associated with the three religions. The social groups related to secondary, higher education and business life exist almost in every culture. Although we have restricted our model to a subset of the domain, it can be easily extended to include other socio-cultural groups.

For example, those related to sports, history, politics and healthcare, those related to Hindu or Buddhist religions or Japanese nation and so forth.

As we have discussed in the previous chapter, information about the conceptual structure of the real world can be discovered in the expressions of the natural language. Therefore, we believe we can acquire knowledge about socio-cultural time by looking at the language expressions used to talk about time by various cultures and social groups. For example, expressions such as ‘Tea Time’, ‘Thanksgiving Day’, ‘School Year’, ‘Sabbath’ demonstrate different cultures’ understanding of time. When we hear ‘Tea Time’ we presumably think of a period of time that is reserved for the activity of drinking tea and we implicitly associate it with England. Similarly, when we hear ‘Thanksgiving Day’, we presumably think of a period of a day associated with USA and with eating a turkey etc. Put in a very simple way, if we want to learn how different cultures and social groups think about time, we can listen to how they talk about it.

Concepts of socio-cultural time periods are denoted by the socio-cultural time expressions. Let us explain this. We stated above that socio-cultural time expressions give us information about how different cultures and social groups conceive of time. Moreover, the expressions themselves do not precisely and unambiguously describe the meaning. In other words, we can hear the expression but to be able to make sense of the expression we need to know the definition of the concept of time that the expression refers to. Thus, the expressions used for talking about time only deliver us the information about how the speakers conceive of time in their particular socio-cultural context but they do not unambiguously describe what their meaning is. For that, the concept behind the expression needs to be investigated.

If we consider the expression ‘Thanksgiving Day’ again, we see that it is composed of two words ‘Thanksgiving’ plus ‘Day’; it is in English and so forth. Nevertheless, this does not suffice for a precise and systematic description of the meaning. The meaning of the expression is implicitly present in our minds; upon hearing it we associate it with the concept of a time period of one day that is specific for USA. With such an association, we are relating the expression we have heard to the specific concept of time, in other words we are referring to the concept that the expression denotes. Thus, in order to understand the meaning of the expression and to make sense of it, we are looking at its denotation.

If we reconsider our goal, which is providing unambiguous, explicit, formal and machine-processable description of knowledge about socio-cultural time, so that it can be used to support temporal Web application systems it is clear that this can only be achieved by referring to the denotations of the socio-cultural time expressions. Therefore, an ontological model at the conceptual level is necessary.

This requirement essentially directs us to the modelling approach we have discussed in the previous chapter. Hence, we are distinguishing between a conceptual level and a lexical level for representing the domain of socio-cultural time. We understand socio-cultural expressions of time at the lexical level and socio-cultural concepts of time at the conceptual level, as being complementary to each other. As a result of this approach, two separate ontologies have been designed and implemented, which are the *Ontology of Socio-Cultural Time Expressions* and the *Ontology of Socio-Cultural Time Concepts*.

The first ontology is a formal representation the socio-cultural time expressions found in the natural language and it does not attempt to provide an unambiguous description of their meaning. On the contrary, it has the purpose to demonstrate the ambiguity present in the socio-cultural time expressions. The second ontology on the other hand, is a formal and unambiguous explication of the meaning of the socio-cultural time expressions.

Once again, our goal is to provide a precise and unambiguous definition of the knowledge about socio-cultural time to support temporal Web application systems, so that they can react more sensitively against the context specific needs of their users. Therefore, we are interested in the meaning of socio-cultural time. Given these facts, the *Ontology of Socio-Cultural Time Concepts* will comprise the focal point of the chapter.

Following general requirements hold for both ontologies:

1. **Typing:** Entries in the ontology need to be typed to reflect the differences between the main categories. For example, category *Socio-Cultural Time Expressions* and category *Calendar Date Expressions* are two distinct types. Consequently, one instance cannot be an instance of both categories (exception: some instances in the *Ontology of Socio-Cultural Time Expressions* do belong to several categories in order to demonstrate the ambiguity of the socio-cultural time expressions).
2. **Category Combination:** It should be allowed to combine existing categories in order to yield new categories. For example, combining the category *Socio-Cultural Time Expressions Related to Nations* with the category *Socio-Cultural Time Expressions Denoting a Time Period of One Day* should yield the category *Socio-Cultural Time Expressions Related to Nations Denoting a Time Period of One Day*.
3. **Stability:** Local changes should not affect the other parts of the ontology, i.e. additions and deletions in one category should not lead to changes in other categories.
4. **Extensibility:** It should be possible to extend the ontology at arbitrary depth and branching level.
5. **Graph Structure:** It should be possible to find an entry (either a time expression or a time concept) starting out from different categories. Therefore, multiple parents should be allowed and the model should have the form of a DAG (not a tree).

In the next sections we will mention the role of the Ontology of Socio-Cultural Time *Expressions* and study the details of the Ontology of Socio-Cultural Time *Concepts*.

There are some naming conventions for both ontologies. As a rule, names of the categories start with a capital letter as in *Socio-Cultural Time Expressions Denoting Time Periods*. Names of instances also start with capital letters, however the instances of the Ontology of Socio-Cultural Time *Expressions* will be quoted. For example, string Holiday will be represented as ‘Holiday’ if it is an instance of the Ontology of Socio-Cultural Time *Expressions*. It will be represented as Holiday (without the quotes), if it is an instance of the Ontology of Socio-Cultural Time *Concepts*. Names of properties (attributes) and names of relations begin with lowercase letters, whereby in most of the cases property names have the prefix *has-* as in *has Duration* or in *has Granularity*. Names of relations also start with lowercase letters as in *subclassOf*.

In order to profit from the existing guiding services provided for ontology development process, we have adopted METHONTOLOGY methodology to a large extent for the construction of the two ontologies. METHONTOLOGY has been chosen because it provides a clear-cut definition of what steps to take during the ontology construction process, in particular during the conceptualization of the ontology. Subsequently, it is possible to provide a formal description of the domain socio-cultural time related to nations, religions, business life & education that is independent of languages and implementation platforms. In the next sections we will observe the *specification*, the *conceptualization* and the *implementation* processes of the Ontology of Socio-Cultural Time *Concepts* w.r.t. METHONTOLOGY.

OWL has been chosen as the ontology language for the formal implementation of the two ontologies out of two reasons: first both ontologies are designed to support Web-based applications, therefore any ontology language would not do. It had to be an ontology language for the Web. Second reason is that OWL is the latest standard for developing ontologies for the Web and it is expressive enough for our purposes. As we have seen, sophisticated tools also exist for editing OWL ontologies. Protégé 2000 has been used as the ontology editor because of the OWL support it provides and the frequently updated discussion list it maintains.

The structure of this chapter is as follows: this introductory section has provided a definition of the domain socio-cultural time and it has recalled the motivation for providing a systematic and unambiguous explication of knowledge about socio-cultural time. It has represented our approach for such an explication and it has given a brief overview of the two ontologies that have been designed and implemented. The means that have been initiated for the development of the two ontologies have also been mentioned.

Subsection 5.1. Role of the Ontology of Socio-Cultural Time *Expressions* gives a detailed explanation of the role of the related ontology within the whole context of the thesis. Subsection 5.2 Purpose and Scope of the Ontology of Socio-Cultural Time *Concepts* specifies the purpose and the scope of the related ontology and demonstrates the *Specification Document* of the ontology. Section 5.3 Conceptualization of the Ontology of Socio-Cultural Time *Concepts* presents a partial *Glossary of Terms*, *Concept Classification Hierarchy*, *Concept Dictionary*, *Binary Relations Table and Diagram* and the *Instances Table* of the related ontology. 5.4 Implementation of the Ontology of Socio-Cultural Time *Concepts* shows the OWL implementation of the ontology. Section 5.5 Applications discusses the possible and the realized applications of the Ontology of Socio-Cultural Time *Concepts*. Here, we will present how we have extracted some parts of the ontology, for example, a subset of socio-cultural time periods by using the RDF query language RDFQL on the OWL model and how we have built a small PROLOG database with the extracted socio-cultural time periods. Such a database can provide the basis for a socio-cultural Web calendar, which in return can support an automated appointment scheduling service for the Web.

5.1 Role of the Ontology of Socio-Cultural Time *Expressions* Related to Nations, Religions, Business Life & Education

The goal of this section is to clarify the role of the Ontology of Socio-Cultural Time *Expressions* within the context of the thesis. Thereby, we will give an overview of the contents of the ontology in terms of its categories, relations and instances. The relationship between the current ontology and the Ontology of Socio-Cultural Time *Concepts* will also be discussed. In a number of classification hierarchies some extracts of the ontology will be depicted.

Ontology of Socio-Cultural Time *Expressions* is a formal representation of a subset of the natural language expressions of time that are related to nations, religions, business life & education. For example, “Halloween” is an expression that is specific for the US American nation, “Christmas” is an expression related to the Christian religion, “Meeting” as an expression is very often used among the social group of business people, “Academic Semester” is an expression used by the specific social group of academia, and so forth. We call such expressions *socio-cultural time expressions* or *expressions of socio-cultural time*. As such, the Ontology of Socio-Cultural Time *Expressions* defines appropriate categories, to which these expressions can be assigned and it organizes the categories containing the expressions in a hierarchical order.

Expressions of socio-cultural time comprise the first of the two partitions of the domain of socio-cultural time related to nations, religions, business life & education and it

corresponds to the lexical level. This means the Ontology of Socio-Cultural Time *Expressions* does not attempt to provide an explicit and an unambiguous description of the meaning.

Socio-Cultural time expressions, as expressions of the natural language, deliver us information about the conception of socio-cultural time. As we have stated, in our regard, by looking at how different social groups and cultures talk about time, it is possible to gain insight to different socio-cultural groups' understanding of the concept of time. In other words, we want to understand the conception of time in a socio-cultural context, but in order to be able to get there we first need to look at the expressions about socio-cultural time. With this idea in mind, the Ontology of Socio-Cultural Time *Expressions* has been developed.

Recapitulating Chapter 4, we have referred to the ambiguity of the expressions of natural language, in particular to the ambiguity of socio-cultural time expressions. We have seen that one expression may denote several concepts and we cannot always precisely determine which concept is being referred to. The role of the Ontology of Socio-Cultural Time *Expressions* is about demonstrating this case. Thus, this ontology has the purpose to represent the ambiguous nature of the socio-cultural time expressions without attempting to explicate their meaning.

In the Ontology of Socio-Cultural Time *Expressions*, difficulties arose when assigning the expressions to appropriate categories because several of them possess more than one meaning. That is, most expressions denote more than one concept. This situation brings about the need for deciding for one meaning i.e. for one concept, but such a decision concerns the conceptual level. Consequently, the Ontology of Socio-Cultural Time *Expressions* exhibits one more time the need for the Ontology of Socio-Cultural Time *Concepts*.

Let us look at some entries in the ontology as well as at the problems we have come across to. Consider the socio-cultural time expression "Sabbath". At the lexical level, Sabbath is an expression predominately used by the Jewish religion and the Israeli nation. Occasionally, one can hear it being used in other socio-cultural groups. Complexities arise, when we look at the meaning of the expression "Sabbath". If we consider "Sabbath" as a member of the set of Jewish-Israeli time expressions, then we are referring to a concept of time that is one day long, that repeats every week and that is always on the 6th day of the week. Moreover, according to the Jewish religion, the concept of Sabbath is associated with a holy day, during which one is exempt from work.

Considering the use of ‘Sabbath’ in other cultures, however, we see that it may refer to another concept of time that is most probably but not necessarily one day long and that implies one’s personal decision to take a day off. It can also be used to mean one’s engagement in a work activity other than the regular work for that day. Clearly, the expression ‘Sabbath’ denotes at least two different concepts.

Another example of an ambiguous socio-cultural time expression is ‘Holiday’, which is an expression used in many languages. According to our observations, this expression is mostly used to indicate some time off due to a specific celebration or out of personal reasons. However, the actual meaning of the expression ‘Holiday’ is very vague. It denotes many different concepts of time that are all necessarily periods of time but are very different in character. According to Merriam Webster’s Dictionary, the expression ‘Holiday’ has at least three senses:

1. Holy Day: a day set aside for special religious observance.
2. a day on which one is exempt from work; specifically a day marked by a general suspension of work in commemoration of an event.
3. a period of relaxation (vacation).

For example, we can call Christmas as ‘Holiday’. Suppose that we find ourselves in late December of a given year and we ask for the ‘Holiday’ plans of a friend of ours. Obviously, here we use the expression ‘Holiday’ to refer to the event of celebrating Christmas and to the time off, which is during and after that event. Now suppose that we are in summer and we are again asking the same question to a friend. If the friend is a business colleague, then with the expression ‘Holiday’ we probably refer to the time concept of Business Vacation that the colleague is going to have. If the friend is a student, then it is very likely that we use the expression ‘Holiday’ to mean Semester Break, which is a period of time when no classes are held. As it can be observed, putting the expression ‘Holiday’ into the perspective of different cultures and social groups, we obtain many different denotations.

As exciting as it is, this situation brings us into a state of ambiguity, where we need to decide for one meaning to avoid confusion and to provide consensus. Socio-cultural time expressions denote concepts and refer to the meaning but they do not provide an explicit and unambiguous description of the meaning. Hence, we could classify socio-cultural time expressions according to ‘the ways we talk about them’. On the basis of the concepts they denote, socio-cultural time expressions could be classified as ‘old-fashioned socio-cultural time expressions’ (e.g. Lord’s Day for Sunday), ‘modern socio-cultural time expressions’ (in this case Sunday for Lord’s Day), ‘socio-cultural temporal expressions of slang’ (e.g. bigtime, ace time) to present how people with different socio-cultural backgrounds talk

about time. Yet, all these would not suffice to deliver us the precise and unambiguous meaning. To put it briefly, the problems we have discussed demonstrate that there is not always a one-to-one relationship between socio-cultural time expressions and the time concepts they denote. In other words, it is not the case that always one expression denotes one concept. Instead, the relationship is frequently one-to-many, where one socio-cultural time expression denotes many socio-cultural time concepts.

As long as the meaning of a socio-cultural time expression is not clarified, that is, as long as it is not pinned down what concept or concepts the expression denotes, it is not possible to provide a systematic and unambiguous description of the domain of socio-cultural time related to nations, religions, business life & education. Moreover, if one socio-cultural time expression denotes more concepts, it is necessary to decide on one concept w.r.t. its relevance to the domain. Otherwise, it will not be possible to eliminate the ambiguity and to provide consensus about the domain. Yet, precise and unambiguous description of the domain as well as providing consensus about the understanding of the domain is the precondition for supporting temporal Web applications such as automated appointment schedulers. Without this, the reasoning components of such applications may have difficulties in drawing the necessary conclusions, due to the imprecise definition and the ambiguity of the information about the domain.

In sum, the Ontology of Socio-Cultural Time *Expressions* as is, demonstrates the need for a conceptual level to enable a precise description of knowledge about socio-cultural time related to nations, religions, business life & education. In the following subsection, we will discuss the purpose, the scope and the contents of the Ontology of Socio-Cultural Time *Concepts* that has been developed as an answer to the need for the conceptual level. Before proceeding to that, we introduce the Ontology of Socio-Cultural Time *Expressions* briefly.

The hierarchical structure of the Ontology of Socio-Cultural Time *Expressions* has the form of a graph (DAG). The top level *category* (a category is sometimes called *class* or *concept* but here we will adopt the term category) is (\top) . All other categories are subcategories of (\top) , that can be combined to obtain further categories, when necessary. As we have stated, the Ontology of Socio-Cultural Time *Expressions* does not suffice to provide an explicit and unambiguous description of the meaning of the expressions. However, in order to be able to determine the categories of the ontology and to be able to assign the expressions to appropriate categories, we do refer to the meaning of the expressions.

Top level category is divided into one subcategory; it is the category *Time Expressions Denoting Time Periods*. As such, this category includes all possible expressions about time, which denote concepts of time that can be explicitly anchored on the time line. Examples are expressions about, calendar dates, days of weeks, months, hours of days, years,

centuries also expressions such as ‘Midnight’, ‘Yesterday’, ‘Next Year’, ‘1700s’, ‘60s’, ‘Medieval Ages’, ‘17th century’, ‘Lunch -Time’, ‘Weekend’, etc. The expressions about time, which denote concepts that cannot be explicitly anchored on the timeline, are not within the scope of the ontology. Examples of such expressions are ‘Sometime in Future’, ‘A While Ago’, ‘Whenever Possible’, ‘Way Before’, et c.

Subcategories of one category are at the same level and they have the same criterion of subdivision. To determine the criterion, we ask the question at the category *Time Expressions Denoting Time Periods* “Does the time expression denote merely a calendar date time period, or does the expression denote a time period that is related to one of the socio-cultural groups specified within the scope of the ontology?” Consequently, all time expressions that denote merely calendar date time periods are classified under the category of *Calendar Date Expressions Denoting Time Periods*. Expressions that belong to this category are those time expressions that explicitly denote a time interval in a given calendar such as calendar days, calendar weeks, months, hours. In our regard, these expressions do not bear socio-cultural characteristics, in other words they are independent of socio-cultural contexts. Examples of such expressions are “12.6.2004”, “January”, “12.00 p.m.”, “8.00 a.m.”, etc. Category *Calendar Date Expressions Denoting Time Periods* underlines the distinction between socio-cultural time expressions and regular time expressions.

Remaining time expressions denoting time periods do bear socio-cultural characteristics, therefore they qualify as expressions denoting socio-cultural time periods. These comprise the second category that is the *Socio-Cultural Time Expressions Denoting Time Periods*. The two categories constitute the third level of the hierarchy and they are at the same level. We refer to the categories that are at the same level as *co-ordinate* categories. Hence, category of *Calendar Date Expressions Denoting Time Periods* and *Socio-Cultural Time Expressions Denoting Time Periods* are co-ordinate categories.

Categories are declared as subcategories, supercategories or co-ordinate categories with respect to their relations to each other in the hierarchy. A subcategory has all the characteristics of its supercategory and at least one further characteristic, which distinguishes it from its co-ordinate categories. Thus, both categories of *Calendar Date Expressions Denoting Time Periods* and *Socio-Cultural Time Expressions Denoting Time Periods* extend the category of *Time Expressions Denoting Time Periods* with further characteristics and they are distinct. Time expressions that belong to the category of *Calendar Date Expressions Denoting Time Periods* are necessarily expressions denoting time periods, additionally they are denoting explicit time periods. For example, ‘Bed Time’, ‘Tomorrow’, ‘Last Month’ cannot be instances of the category *Calendar Date Expressions Denoting Time Periods* because they do not denote concepts of time periods that are explicit. Concept Bed Time can be, as a matter of fact, any time in the evening or

even during the day. In order to determine the time concept of Tomorrow or Last Month current day and current month need to be known.

Time expressions that belong to the category of *Socio-Cultural Time Expressions Denoting Time Periods* are necessarily time expressions denoting time periods and they have additionally socio-cultural characteristics. For example, “Columbus Day” is a time expression denoting a time period of one day and it is an expression used in the USA. Likewise, “Yom Kippur” is an expression denoting a concept of a time period, which is also one day long. This expression is used in the Jewish religion and the Israeli nation.

Based on the general requirements mentioned afore, the two categories are two distinct types. Except for some special cases, which we will refer to soon, no time expression can be a member of both categories. An expression that belongs to the category *Calendar Date Expressions Denoting Time Periods* has type *Calendar Date Expressions Denoting Time Periods*, whereas an expression that belongs to the category *Socio-Cultural Time Expressions Denoting Time Periods* has type *Socio-Cultural Time Expressions Denoting Time Periods*. The two expressions are two unique expressions that have different types.

The category *Calendar Date Expressions Denoting Time Periods* is not broken down into any further categories, whereas the category of *Socio-Cultural Time Expressions Denoting Time Periods* is. Two questions have to be answered at the category of *Socio-Cultural Time Expressions Denoting Time Periods* to obtain further subcategories. These questions are “*how long?*” and “*from where?*” The first question targets at extracting information about the *duration* of the time period that the expression denotes and the second question targets at extracting the *origin* of the time period that the expression denotes. Thus, first question reveals the *temporal* dimension of *Socio-Cultural Time Expressions Denoting Time Periods* and the second question reveals the *socio-cultural* dimension. Once again, with these questions we are referring to the meaning of the questions as this is necessary to determine the categories.

Consequently, further subcategories of the category *Socio-Cultural Time Expressions Denoting Time Periods* emerge. These are *Socio-Cultural Time Expressions Denoting Time Periods Related to Nations*, *...Related to Religions*, *... Related to Business Life & Education*, *Socio-Cultural Time Expressions Denoting Time Periods with Duration of One Day*, *...with Duration of Longer than One Day* and finally *...with Duration of Shorter than One Day*, which are each other’s co-ordinate categories.

The majority of socio-cultural time expressions have been assigned to appropriate categories on the basis of these criteria. However, as we have mentioned previously, some expressions such as the expression “Holiday” and the expression “Sabbath” are vague in

meaning, i.e. they denote multiple concepts, therefore they belong to multiple categories w.r.t. the classification criteria. Hence, these expressions have not been assigned to a *single* category but to *multiple* categories. For example, the expression “Holiday” has been assigned to both the category *Socio-Cultural Time Expressions Denoting Time Periods with Duration of One Day* and to *Socio-Cultural Time Expressions Denoting Time Periods with Duration of Longer than One Day* because the use of this expression in the natural language denotes both a period of one day and a period that is longer than one day. In the Ontology of Socio-Cultural Time *Concepts*, however, the time concept Holiday is modelled as a socio-cultural time period with duration of one day. In other words, the time concept Holiday is the member of *only* the category *Socio-Cultural Time Periods with Duration of One Day*.

As a result of the ambiguity of socio-cultural time expressions, there are several other cases, where one expression is assigned to multiple categories in the Ontology of Socio-Cultural Time Expressions. In the Ontology of Socio-Cultural Time *Concepts*, these multiple assignments are reduced to single assignments and the associated concepts are *marked in a special way* to indicate the exceptional situation. We will refer back to this issue one more time in the Ontology of Socio-Cultural Time *Concepts*. Here is a depiction of the top level category and some high-level categories of the classification hierarchy:

The Top level and the high levels of the Ontology

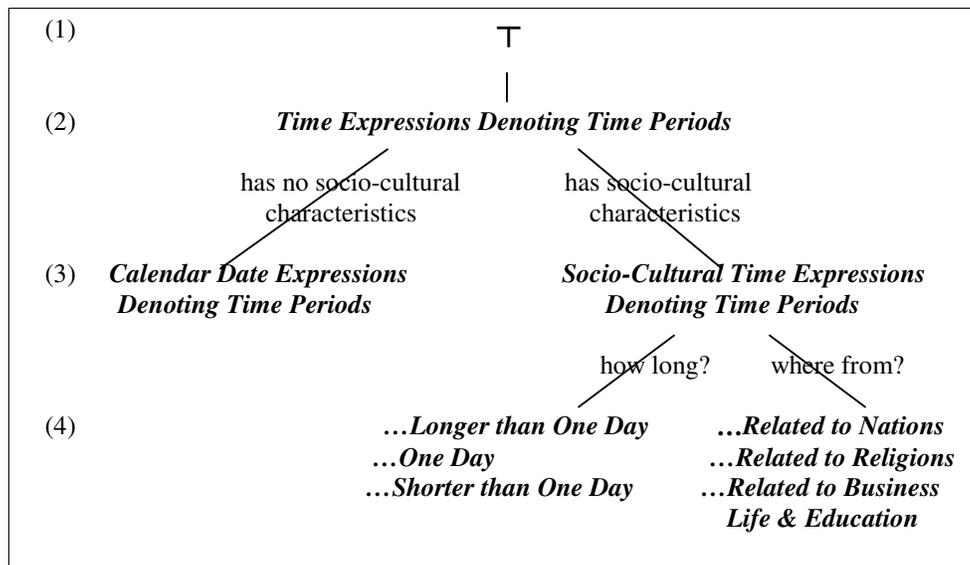


Figure 1

A partial classification hierarchy and the classification criteria w.r.t. subclassOf relationship

Clearly, the classification criteria can be extended to include finer categories. For example, a category *Socio-Cultural Time Expressions Denoting Time Periods of One Week* could be defined, which would then include expressions such as “Holy Week”, “Passion Week” and so forth. Further categories, can be defined to include expressions denoting time periods of half a day, afternoons, between 12.00 and 13.00 (e.g. ‘Lunch Time’) and so forth. Similarly, *Socio-Cultural Time Expressions Denoting Time Periods* can be extended to include categories such as *Socio-Cultural Time Expressions Denoting Time Periods Related to Sports* (e.g. ‘Training Hours’, ‘Camp Days’, ‘Time Out’), *...Related to Healthcare* (e.g. ‘Surgery Hours’, ‘Consultation Hours’), *...Related to History* (e.g. ‘Renaissance, Victorian Era’).

At this time, we arrive at the fourth level of the classification hierarchy and we start to combine the co-ordinate categories in an exhaustive manner so that in the end every possible combination has been realized. More precisely, we combine the categories *Socio-Cultural Time Expressions Denoting a Time Period of One Day, ...Longer than One Day* and *...Shorter than One Day* with the categories of *Socio-Cultural Time Expressions Denoting Time Periods Related to Nations, ... Related to Religions* and *...Related to Business Life & Education*. As a result, we obtain combination (or intersection) categories such as *Socio-Cultural Time Expressions of Nations Denoting a Time Period of One Day, Socio-Cultural Time Expressions of Religions Denoting a Time Period of Longer than One Day*, and so forth. These categories constitute the fifth level of the hierarchy.

Based on the reasons that have been provided before, particular attention is paid to the nations USA, Turkey, Germany, Israel, to the religions Islam, Christianity, Judaism and to the social groups involving business people and members of secondary and higher education. Therefore, categories concerning the relevant religions, nations and social groups have been defined and they have been subordinated to one of the appropriate combinatory categories defined above. For example, the category of *Turkish Time Expressions Denoting Time Periods with Duration of One Day* is subordinated to the category of *Socio-Cultural Time Expressions Related to Nations Denoting Time Periods with Duration of One Day* and the category of *Socio-Cultural Time Expressions Related to Higher Education Denoting Time Periods with Duration of Longer than One Day* is subordinated to the category of *Socio-Cultural Time Expressions Related to Business Life and Education Denoting Time Periods with Duration of Longer than One Day*. Here is another depiction of the fourth, fifth and sixth levels of the classification hierarchy that shows a combination category and its subcategory:

Combination of the Categories at the 4th Level

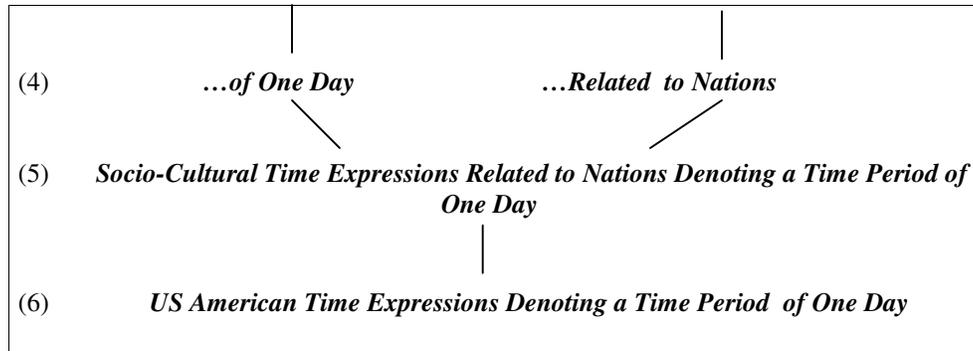


Figure 2

The combination of categories and the subcategory of one combination category w.r.t. subclassOf relationship

All four nations, three religions and three social groups are categorised in this manner. Note the graph structure of the classification hierarchy. Within the general design requirements, we have specified that it is desired to be able to find an instance starting out from different points in the hierarchy. Considering the depiction above, it would be possible to find an instance assigned to the category of *US American Time Expressions Denoting a Time Period of One Day* both starting out from the category *Socio-Cultural Time Expressions Denoting Time Periods of One Day* and from category *Socio-Cultural Time Expressions Denoting Time Periods Related to Nations*.

Clearly, it is possible to extend the classification hierarchy at the sixth level to include further nations, religions and social groups. Lowest level categories of the classification hierarchy include categories such as *Israeli-Jewish Time Expressions Denoting a Time Period of One Day* or *Turkish-Islamic Time Expressions Denoting a Time Period of One Day*, etc. These categories were necessary because in our collection some expressions are of both Islamic and Turkish origin. Similarly, some expressions are of both Jewish and Israeli origin. Since an expression is not allowed to be the instance of more than one category (except for the special cases), we have defined the above mentioned combination categories.

Instances of the Ontology of Socio-Cultural Time Expressions Related to Nations, Religions, Business Life & Education are the expressions of socio-cultural time denoting time periods. For example, the expressions ‘St. Patrick’s Day’, ‘Academic Trimester’ or ‘Day of Repentance and Prayer’ constitute the instances of the ontology. Every instance is assigned to an appropriate category and in cases of ambiguity to multiple categories. For example, the expression ‘St. Patrick’s Day’ is an instance of the category *Christian Time*

Expressions Denoting Time Periods of One Day and the expression “Academic Trimester” is an instance of the category *Socio-Cultural Time Expressions Related to Higher Education Denoting Time Periods with Duration of Longer than One Day*.

Some categories do not have *direct* instances. That is, some categories have instances in terms of the instances of their subcategories. The category *Socio-Cultural Time Expressions Denoting Time Periods* constitutes such a case. It does not have direct instances itself but its subcategories do. For example, the expression “St. Patrick’s Day” above, which is a direct instance of the category *Christian Time Expressions Denoting Time Periods with Duration of One Day*, is at the same time an *indirect* instance of the category *Socio-Cultural Time Expressions Denoting Time Periods* because the former category is a subcategory of the latter.

So far, we have examined the categories and the instances of the Ontology of Socio-Cultural Time *Expressions*. Before we proceed to the issues, where the current ontology differs from the Ontology of Socio-Cultural Time *Concepts*, we inspect the *properties* (or attributes) of the ontology.

There are five different types of properties defined in the ontology. These properties are, *denotes Time Period of Fixed Date*, *denotes Time Period of Variable Date*, *denotes Time Period of General Suspension of Classes*, *denotes Time Period of General Suspension of Work*. As such, the properties comprise the characteristics of a category. Every expression that is an instance of the category will automatically carry the characteristics i.e. the properties of that category. Properties in the Ontology of Socio-Cultural Time *Expressions* are defined only at the category *Socio-Cultural Time Expressions Denoting Time Periods* because we are particularly interested in defining the characteristics of the expressions of socio-cultural time. All the subcategories of the category *Socio-Cultural Time Expressions Denoting Time Periods* carry the characteristics of their supercategory. In other words, they *inherit* the properties.

This means that all expressions that are assigned to the category *Socio-Cultural Time Expressions Denoting Time Periods* or to one of its subcategories will be furnished with these properties. Put another way, the instances will carry all the characteristics of the category they belong to, which distinguish them from the instances of other categories. So, let us explain the meaning and the function of the properties.

1. *denotes Time Period of Fixed Date* property is defined at the category of *Socio-Cultural Time Expressions Denoting Time Periods*, which is at the same time the subject value of the property. The object value is a boolean, hence the property is a binary relation between the an instance of the ontology that is a member of the category *Socio-Cultural Time*

Expressions Denoting Time Periods and a boolean, which is a member of the category *Literal*. The category *Literal* does not show up in the actual classification hierarchy and it can be considered as a system class that functions as a container for all kinds of literal values such as strings, integers, booleans and so forth defined in the ontology. The property is of the form:

Category	Property (attribute)	Property Value
<i>Socio-Cultural Time Expressions Denoting Time Periods</i>	<i>denotes Time Period of Fixed Date</i>	Boolean

Table 2

Subject value and the object value of the property *denotes Time Period of Fixed Date*

Thus, each socio-cultural time expression that is an instance of the category *Socio-Cultural Time Expressions Denoting Time Periods* or an instance of one of its subcategories carries the property *denotes Time Period with Fixed Date* that can be either TRUE or FALSE. So, each expression reports whether or not it refers to a period of time whose date is fixed. For example, if we define the expression “St. Valentine’s Day” to be the instance of the category *Christian Time Expressions Denoting Time Periods with Duration of One Day*, then it will be necessarily equipped with the property *denotes Time Period of Fixed Date*. Thus, it will be related to a boolean value that can be either TRUE or FALSE. St. Valentine’s Day happens on 14th of February each year, so we can state the following: “St. Valentine’s Day” *denotes Time Period of Fixed Date* TRUE. We can translate this statement as “St. Valentine’s Day is a socio -cultural time expression that denotes a time period of a day with a fixed date on the timeline”. The purpose of this attribute is to demonstrate the socio-cultural time expressions that denote periods of time, which can always be anchored on the same fraction of the timeline.

2. *denotes Time Period of Variable Date* property is defined at the category of *Socio-Cultural Time Expressions Denoting Time Periods*, which is the subject value of the property. The object value is a boolean, hence the property is a binary relation between an instance of the ontology that is a member of the category *Socio-Cultural Time Expressions Denoting Time Periods* and a boolean value, which is a member of the category *Literal*. It is of the form:

Category	Property (attribute)	Property Value
<i>Socio-Cultural Time Expressions Denoting Time Periods</i>	<i>denotes Time Period of Variable Date</i>	Boolean

Table 3

Subject value and the object value of the property *denotes Time Period of Variable Date*

Thus, each socio-cultural time expression that is an instance of the category *Socio-Cultural Time Expressions Denoting Time Periods* or an instance of one of its subcategories carries the property *denotes Time Period of Variable Date* that can either be TRUE or FALSE. So, each expression reports whether or not it refers to a period of time whose date is variable. For example, if we define the expression ‘Easter Monday’ to be the instance of the category *Christian Time Expressions Denoting Time Periods with Duration of One Day*, then it will necessarily carry the property *denotes Time Period of Variable Date*. Thus, it will be related to a boolean value that can be either TRUE or FALSE. Easter Monday happens on a different date each year, so we can state for the following: ‘Easter Monday’ *denotes Time Period of Variable Date* TRUE, which can be translated as ‘Easter Monday is a socio-cultural time expression that denotes a time period that is a day long with a variable date on the timeline’. The purpose of this attribute is to demonstrate the socio-cultural time expressions that denote periods of time, which cannot be anchored on the same fraction of the timeline.

3. *denotes Time Period of General Suspension of Classes* property is defined at the category of *Socio-Cultural Time Expressions Denoting Time Periods*, which is the subject value of the property. The object value is a boolean, hence the property is a binary relation between an instance of the ontology that is a member of the category *Socio-Cultural Time Expressions Denoting Time Periods* and a boolean value, which is a member of the category *Literal*. It is of the form:

Category	Property (attribute)	Property Value
<i>Socio-Cultural Time Expressions Denoting Time Periods</i>	<i>denotes Time Period of General Suspension of Classes</i>	Boolean

Table 4

Subject value and the object value of the property *denotes Time Periods of General Suspension of Classes*

Thus, each socio-cultural time expression that is an instance of the category *Socio-Cultural Time Expressions Denoting Time Periods* or an instance of one of its subcategories will carry the attribute *denotes Time Period of General Suspension of Classes* that can be either TRUE or FALSE. So, each expression reports whether or not it refers to a period of time that is associated with a change in the usual flow of education life (i.e. periods of time when there is no teaching and no classes are held). For example, if we define the expression ‘Semester Break’ to be the instance of the category *Socio-Cultural Time Expressions Denoting Time Periods Related to Higher Education with Duration of Longer than One Day*, then it will necessarily carry the attribute *denotes Time Period of General Suspension of Classes* and will be related to a boolean value that can be either TRUE or FALSE. During Semester Break no classes are held at a university so we can state the following:

‘Semester Break’ *denotes Time Period of General Suspension of Classes* TRUE, which can

be translated as ‘Semester Break is a socio-cultural time expression that denotes a time period longer than a day, when no classes in higher education are held’.

4. *denotes Time Period of General Suspension of Work* property is defined at the category of *Socio-Cultural Time Expressions Denoting Time Periods*, which is the subject value of the property. The object value is a boolean, hence the property is a binary relation between an instance of the ontology that is a member of the category *Socio-Cultural Time Expressions Denoting Time Periods* and a boolean value, which is a member of the category *Literal*. It is of the form:

Category	Property (attribute)	Property Value
<i>Socio-Cultural Time Expressions Denoting Time Periods</i>	<i>denotes Time Period of General Suspension of Work</i>	Boolean

Table 5

Subject value and the object value of the property *denotes Time Period of General Suspension of Work*

Hence, each socio-cultural time expression that is an instance of the category *Socio-Cultural Time Expressions Denoting Time Periods* or an instance of one its subcategories carries the property *denotes Time Period of General Suspension of Work* that can be either TRUE or FALSE. So, each expression reports whether or not it refers to a period of time that is associated with a change in the usual flow of business life (i.e. periods of time when business are officially closed, no mail is delivered and there is no trade) For example, during the time period St. Patrick’s Day there is no general suspension of work and the business carries on same as on the regular days so we can state the following: ‘St. Patrick’s Day’ *denotes Time Period of General Suspension of Classes* FALSE. We can translate this as ‘St. Patrick’s Day is a socio-cultural time expression that does not denote a period of time, when work and official businesses are suspended based on the determination of a legal authority’.

As we have discussed in the previous chapter, the properties above disclose how the expressions of socio-cultural time deliver information about the underlying conceptual structure. Thus, the properties refer to the meaning of the expressions, however the meaning is not determined in an explicit and unambiguous manner. This will be done in the next ontology that models the concepts. If the information delivered by these properties is formally and unambiguously described in the ontology at the conceptual level, i.e. in the Ontology of Socio-Cultural Time *Concepts*, then this kind of information can facilitate reasoning, for example, for appointment scheduling processes. On the basis of this information, a *reasoning mechanism* can conclude whether or not a given period of time is official working time, or teaching time. It can infer whether or not a specific time period of a given year will correspond to the same time fraction also next year and in the following years. To underline one more time, these properties only deliver information to the

ontology at the conceptual level, therefore the reasoner can only refer to the ontology at the conceptual level that makes use of this information and redefines it in an unambiguous manner.

There are similarities and differences between the Ontology of Socio-Cultural Time *Expressions* and the Ontology of Socio-Cultural Time *Concepts*. As it has been mentioned several times, the former ontology assigns the expressions of socio-cultural time that are a subset of natural language expressions to appropriate categories, which are organized in a hierarchical order w.r.t. subclass-superclass relationship. The latter on the other hand, assigns the concepts of socio-cultural time that are denoted by the expressions to appropriate categories, which are organized in a hierarchical order. As such, the first ontology does not attempt to describe the meaning of the expressions in an unambiguous manner, whereas the second does.

The distinction between the two ontologies can be observed by looking at the definition of the categories and properties of the Ontology of Socio-Cultural Time *Expressions*. Category names such as *Socio-Cultural Time Expressions Denoting Time Periods* or *Socio-Cultural Time Expressions Denoting Time Periods Related to Religions* point out to the fact that the expressions only denote the associated concepts and even though they refer to the meaning, they do not provide a clarification of the meaning. As a result of the ambiguity of the expressions, there are cases in the Ontology of Socio-Cultural Time *Expressions*, where one instance (expression) is assigned to *multiple* categories, whereas in the second ontology this is strictly avoided. Furthermore, in the Ontology of Socio-Cultural Time *Expressions*, there are no properties such as *has Similar Meaning*, *has Subordinate Concept*, or *has Superordinate Concept* that relate the categories to each other because they refer to the meaning of the expressions; in other words they refer to the concepts. Out of same reasons, properties such as *has Duration*, *has Granularity* and so forth are not defined at any category in the Ontology of Socio-Cultural Time *Expressions*. Consequently, such properties are defined either in the Ontology of Socio-Cultural Time *Concepts* as that is the ontology, which attempts to provide an unambiguous explication of the meaning of the expressions of socio-cultural time. This issue will be discussed in detail in the forthcoming sections.

Instances of the ontology are the expressions of socio-cultural time related to nations, religions, business life & education. As such, the instances are to be understood as representations of different lexical forms of talking about socio-cultural time. Some examples of instances are expressions such as ‘Martin Luther King’s Birthday’, ‘Academic Year’, ‘Good Friday’ and so forth. Each instance has the type of the category it belongs to. For example, ‘Martin Luther King’s Birthday’ is an expression, which denotes a time period of one day and which is used to talk about the specific day (every third Monday of

every January) in the USA that is reserved to celebrate the birthday of the assassinated civil rights fighter Reverend Dr. Martin Luther King. Based on this information, the expression is assigned to the category *US American Time Expressions Denoting Time Periods of One Day* so now it has the type *US American Time Expressions Denoting Time Periods of One Day*. In a similar way, the expression “Academic Year” is an instance of the category *Socio-Cultural Time Expressions Related to Higher Education Denoting a Time Period of Longer than One Day* and the expression “Good Friday” is an instance of the category *Christian Time Expressions Denoting a Period of One Day*.

In order to provide an explicit and precise definition of the socio-cultural time and eventually to be able to provide support to automated temporal Web application systems, we refer to the concepts that the expressions denote. For each expression, we determine the concept, which is most relevant to the domain and include only that concept in the Ontology of Socio-Cultural Time *Concepts* as the denotation of the associated socio-cultural time expression. Thus, each socio-cultural time expression has one associated socio-cultural time concept in the Ontology of Socio-Cultural Time *Concepts*, which can be understood as the meaning of the expression.

As we have mentioned, the expression “Holiday” is assigned to *two different categories* because of its ambiguous nature. Thus, it is both an instance of the category *Socio-Cultural Time Expressions Denoting a Time Period of One Day* and an instance of the category *Socio-Cultural Time Expressions Denoting a Time Period of Longer than One Day* in the Ontology of Socio-Cultural Time *Expressions*. Its associated concept Holiday, however, is *only* assigned to the category of *Socio-Cultural Time Periods with Duration of One Day* in the Ontology of Socio-Cultural Time *Concepts*. Hence, we have determined one socio-cultural time concept as the only interpretation of the expression “Holiday” in the Ontology of Socio-Cultural Time *Concepts*. We will come back to this case one more time in the next subsection.

We conclude this subsection with the following two figures that show the subclass and instanceOf relationships of the classification hierarchy and the multiple assignment of the expression “Holiday” as an instance of the both categories *Socio-Cultural Time Expressions Denoting a Time Period of One Day* and *Socio-Cultural Time Expressions Denoting a Time Period of Longer than One Day*:

Subclass and InstanceOf Relationships

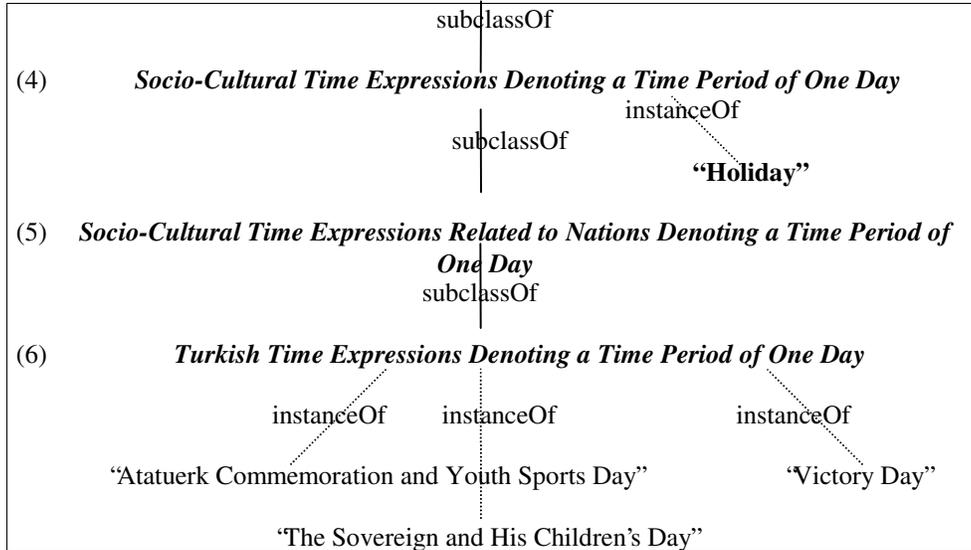


Figure 3

The expression ‘Holiday’ is an instance of the category *Socio-Cultural Time Expressions Denoting a Time Period of One Day*

Subclass and InstanceOf Relationships

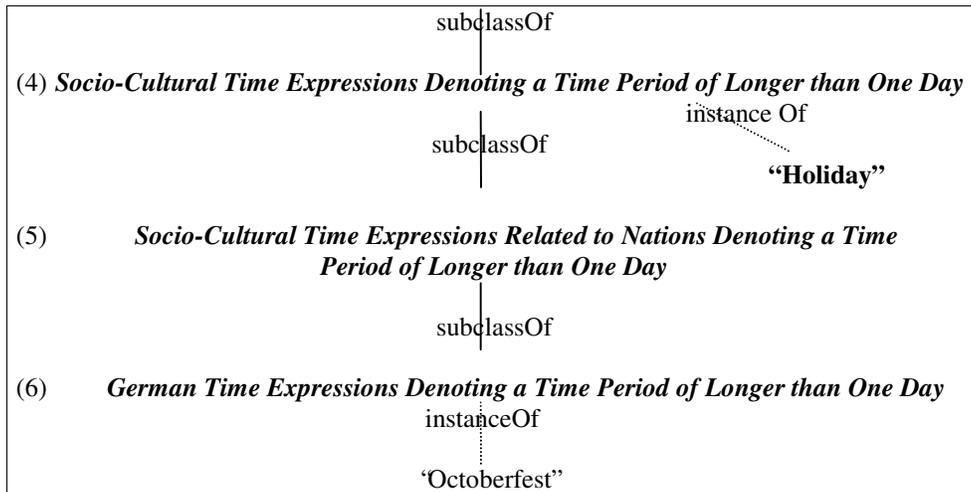


Figure 4

The expression ‘Holiday’ is also an instance of the category *Socio-Cultural Time Expressions Denoting a Time Period of Longer than One Day*

In this section, we have explained the role of the Ontology of Socio-Cultural Time *Expressions* within the context of this thesis. We have stated that socio-cultural time expressions deliver information about the underlying conceptual structure of socio-cultural time and we have mentioned that as a result of this fact Ontology of Socio-Cultural Time *Expressions* has been designed. We have also mentioned that the Ontology of Socio-Cultural Time *Expressions* alone falls short to provide a precise and explicit description of the domain of socio-cultural time related to nations, religions, business life & education because of the ambiguous nature of the expressions of socio-cultural time. We have demonstrated and discussed examples about the complexities that have arisen as a result of this fact. Thus, we have pointed out to the necessity of a model at the conceptual level and justified the need for the Ontology of Socio-Cultural Time *Concepts*. We have presented some categories, some instances and the attributes defined in the Ontology of Socio-Cultural Time *Expressions* and demonstrated some classification hierarchies. Finally, we have provided a brief comparison of the current ontology and the Ontology of Socio-Cultural Time *Concepts*.

5.2 Purpose and Scope of the Ontology of Socio-Cultural Time Concepts Related to Nations, Religions, Business Life & Education

In this section we will examine the purpose and the scope of the Ontology of Socio-Cultural Time *Concepts* in detail. We have already clarified the need for such a conceptual level to provide a description of the domain socio-cultural time related to nations, religions business life & education in a precise and unambiguous manner. This section will demonstrate, how the Ontology of Socio-Cultural Time *Concepts* supplies this need. Thereby, an overview of the categories, the attributes, the relations and the instances of the ontology will be provided. The similarities and the differences between the Ontology of Socio-Cultural Time *Concepts* and Ontology of Socio-Cultural Time *Expressions* will be recapitulated.

General requirements concerning the design that have been defined and explained previously, apply to the Ontology of Socio-Cultural Time *Concepts*. To recall, these requirements are typing, category combination, stability, extensibility and graph structure. At the end of this subsection, we will generate an *Ontology Specification Document* for the Ontology of Socio-Cultural Time *Concepts*, according to the METHONTOLOGY. This document will present the Ontology of Socio-Cultural Time *Concepts* in a nutshell.

As we have pointed out many times, a precise, unambiguous and systematic description is essential if our goal is to support temporal Web application systems by acquainting them with a different notion of time i.e. the notion of socio-cultural time. This way, they can become more (socio-cultural) context sensitive and they can better react against the context

specific needs and preferences of their users. Let us recall the argument briefly why this kind of support is necessary and describe the path that lead to the development of the Ontology of Socio-Cultural Time *Concepts*.

Today, as a result of the modern technology, the interaction between people from different socio-cultural contexts is very high. However, different people may have different conceptions about the real world and a reason for this is the different socio-cultural contexts that the people belong to. Often, when members of different socio-cultural groups interact with each other they take their own conception of the world as a benchmark. So, they fail to recognize the fact that each member, depending on the socio-cultural context, may have a different conception about a common issue. As a result, communication problems arise. As we have seen previously, same is the case for the conception of time.

There is a conception of time that exists independently of the absolute conception of time given in natural science and that is entirely dependent on cultures and social groups. However, this conception of time is implicitly present in people's minds and in most cases members of one socio-cultural group assume that members of the other socio-cultural group would share the same conception of time with them. Like in the previous Summer Semester example, the members of Turkish culture may assume that there is no Summer Semester in German academic system because there is none in Turkish academic system or the opposite way around. Such false assumptions and the consequent communication problems could be avoided, if the implicit conceptions of time are made explicit and shared with others.

Within the scope of this thesis, we assume that the socio-cultural context dependent conception of time is also present on the Web and it plays a role during the interaction on the Web. Therefore, we defend the idea that an explicit description of socio-cultural time is essential for the Web. Today, billions of people from different countries, cultures and social groups are connected to Web and they continuously interact with each other. Moreover, people from different social-contexts develop software applications to be used on the Web that are tailored for their context dependent needs and expectations. Quite often, it is the case that such software applications interact with each other on the Web in order to accomplish common tasks. Yet, these interactions involve a socio-cultural context specific conception of time that has not been explicitly defined. Therefore, we believe in the necessity of the explicating socio-cultural context dependent conception of time to be able to avoid possible communication problems between people and between software applications on the Web. Once this conception of time is defined in an explicit, systematic and machine processable way, it can be used to support temporal Web application systems so that they can react in a more sensitive way to the users' culture specific needs.

Starting out with this motivation, we have defined our task to provide a formal, explicit, unambiguous and systematic description of knowledge about socio-cultural time related to nations, religions and business life and education for the Web to support temporal Web application systems such as automated appointment schedulers. We believe appointment scheduling is a task, where different conceptions of time can be observed frequently and where they play an important role.

Acknowledging that the expressions of natural language deliver information about the conceptual structure of the real world, we have turned our attention to the expressions of socio-cultural time. Thus, as a first step we have developed the Ontology of Socio-Cultural Time *Expressions*. However, we have observed that socio-cultural time expressions cannot provide us with the essential conceptual explicitness, precision and systematics due to the ambiguous nature of the expressions. To achieve this, a conceptual level is needed, where the meaning of socio-cultural time expressions is unambiguously described. So, we have developed the Ontology of Socio-Cultural Time *Concepts* to be able to accomplish our task. In brief, we have partitioned the domain socio-cultural time related to nations, religions and business life & education into two. The first partition is a collection of time expressions of natural language related to the specific Socio-Cultural groups mentioned above, which we call ‘socio-cultural time expressions’. The second partition of the domain corresponds to a collection of concepts of socio-cultural time periods denoted by these socio-cultural time expressions.

As such, the Ontology of Socio-Cultural Time *Concepts* is a model of the concepts denoted by the expressions in the Ontology of Socio-Cultural Time *Expressions*. Therefore, to a large extent, the structure of the first ontology corresponds to the structure of the second ontology. Yet, there are also significant differences.

The major point, where the two ontologies part from each other is the meaning. The Ontology of Socio-Cultural Time *Concepts* models the concepts of socio-cultural time, whereas the Ontology of Socio-Cultural Time *Expressions* models the expressions of socio-cultural time. More precisely, the subject of the former is the concepts and the subject of the latter is the expressions. As a result, in the Ontology of Socio-Cultural Time *Expressions*, some instances may belong to several categories at the same time to demonstrate the ambiguity of the expressions. In the Ontology of Socio-Cultural Time *Concepts* this is not possible. In our collection of socio-cultural time expressions, each expression necessarily denotes a concept of time period. Therefore, categories of the Ontology of Socio-Cultural Time *Concepts* are categories of time periods (whereas the categories of the other ontology are categories of time expressions denoting time periods).

We have discussed thoroughly that socio-cultural time expressions are often vague in meaning. Frequently, one socio-cultural time expression denotes several socio-cultural time concepts, in our case socio-cultural time periods. The expressions of “Holiday” and “Sabbath” are some examples. We have also stated that in order to be able to avoid the ambiguity and to provide precise meaning and consensus about the domain, a decision needs to be taken concerning the meaning of the expressions. More precisely, one concept and only one concept should be determined as the denotation of the expression at hand and only this concept should be included in the model. This would amount to allowing only one possible interpretation for a socio-cultural time expression by reducing the relationship between the expression and the concepts it denotes from one-to-many to one-to-one. This practice is similar to saying that a given expression has exactly one meaning and only that meaning. Once we have decided on one meaning, it can be precisely described and consensus can be achieved if this description would be shared and accepted by others. So, Ontology of Socio-Cultural Time *Concepts* has the purpose of explicating the meaning of socio-cultural time (related to nations, religions and business life & education) without ambiguity and providing consensus about the domain.

Consequently, each concept of socio-cultural time is classified *only under one* category (unlike the case in the former ontology). Referring back to example with the expression “Holiday”, in the Ontology of Socio-Cultural Time *Concepts* the socio-cultural time concept Holiday is defined as “any day that is 24 hours long and that is associated with a special religious observance, or a national celebration, or with a celebration related to a social group, which in some cases indicates a general suspension of work or classes”. This is the one and the only definition present in the Ontology of Socio-Cultural Time *Concepts*. In other words, this is the one and the only interpretation of the socio-cultural time expression “Holiday” that can be found in our conceptual model for the domain of socio-cultural time related to nations, religions and business life & education. In the documentation of Ontology of Socio-Cultural Time *Concepts* such concepts are *marked with a sign “©”* to indicate that they have been *standardized*. In other words, concepts such as the concept Holiday or the concept Sabbath in our model carry such a sign to inform that in the natural language their associated expressions denote also other socio-cultural time concepts. Accordingly, in the Ontology of Socio-Cultural Time *Concepts* the concept Holiday and the concept Vacation for example are treated as two distinct concepts. In the next subsection such socio-cultural time concepts are referred to in detail.

There is an additional aspect that the Ontology of Socio-Cultural Time *Concepts* considers, which involves the possibility of linking up the ontology with a temporal type system. Let us explain this. We have mentioned the purpose of the ontology several times; provide a precise and systematic description of the socio-cultural time related to nations, religions and business life & education to support temporal Web application systems such as

automated appointment schedulers so that they can react more sensitively to the context specific needs of their users. If we reconsider this purpose, we can see that with the ontology we are not targeting at providing yet another formal description of temporal information. Instead, we want to provide additional information, in our case socio-cultural temporal information, to the existing formal temporal information. Moreover, we do not aim to conduct calendrical calculations for the time periods defined in the ontology. We assume that temporal systems exist that pin down the socio-cultural temporal information being described in the ontology to the desired calendar system. An example of such a temporal type system is *Multi-Calendar Temporal Type System for (Semantic) Web Query Languages* [80]. The system will enable the definition of regular time concepts such as *hour* and *day* as well as the definition of socio-cultural time concepts like *Teaching Term* and *Christmas Day* for Web query languages.

In order to facilitate a seamless integration with such a temporal type system, the socio-cultural time ontology needs to provide ways to relate socio-cultural temporal information to regular temporal information. This can be done by explicating the regular temporal information embedded in the socio-cultural temporal information. Therefore, in the Ontology of Socio-Cultural Time *Concepts* each entry of socio-cultural time concept delivers also regular temporal information. More concretely, each instance of socio-cultural time concept like the Thanksgiving Day, Sabbath, Semester is furnished with several properties such as *has Duration*, *has Granularity*, *has Index* and so forth, that deliver regular temporal information about that particular instance of socio-cultural time concept. Similar as in the previous ontology, the properties are defined at the category of *Socio-Cultural Time Periods*, thus each instance of this category or one of its subcategories carries these properties. Next subsection will explain the meaning and the function of the properties in detail.

Instances of the Ontology of Socio-Cultural Time *Concepts* are the concepts of socio-cultural time that are in our model necessarily instances of time periods. Recall that the instances of the Ontology Socio-Cultural Time *Expressions* are the instances of natural language expressions of socio-cultural time. As such, socio-cultural concepts of time, which are time periods, represent the different concepts of socio-cultural time. For example, instances such as Martin Luther King's Birthday, Academic Year and Good Friday are instances of socio-cultural time periods, in other words they have the type socio-cultural time period. Accordingly, the time concept Martin Luther King's Birthday is an instance of *US American Time Periods with Duration One Day*. The time concept Academic Year is an instance of the category *Socio-Cultural Time Periods Related to Higher Education with Duration of Longer than One Day* and the time concept Good Friday is an instance of the category *Christian Time Periods with Duration One Day*.

To conclude, we present the *Ontology Specification Document* for the Ontology of Socio-Cultural Time Concepts according to METHONTOLOGY.

Ontology Specification Document

Domain	Socio-Cultural Time Concepts Related to Nations, Religions, Business Life & Education
Purpose	Ontology about time concepts (of time periods) that formally captures various conceptions of time specific to religions, nations and business life & education. Its purpose is to provide a precise and systematic description of the socio-cultural time to support temporal Web application systems such as automated appointment scheduling services with additional temporal information so that they can react more sensitively to the context specific needs of their users.
Formality Level	Highly Formal
Scope	<ul style="list-style-type: none"> ▪ List of 90 socio-cultural time periods that are specific to religions, nations and business life & education. e.g. Oktoberfest, Semester Break, ... ▪ List of 5 regular time periods that are <u>not</u> specific to religions, nations or business life & education. e.g. January, 17-06-2004, 17th Century, ... ▪ List of related concepts such as <i>Time Periods, Calendar Date Periods, Socio-Cultural Time Periods, Socio-Cultural Time Periods of Religions,</i> ▪ Properties that characterize the related concepts. e.g. <i>fixed Calendar Date, implies General Suspension of Classes, ...</i>
Sources of Knowledge	Multicultural on-line calendars and mailing lists on the Web, books, conversations etc...
Examples of Ontology's Competency Questions	<ul style="list-style-type: none"> ▪ Is the time period merely a calendar date time period or is it a time period that is related to a nation, to a religion, to the social group of business people or to the social group of people related to education ? ▪ What is the duration of the socio-cultural time period (how long)? ▪ What is the origin of the time socio-cultural period? (where does it come from)? ▪ Which nation is the socio-cultural time period related to (USA, Turkey, Germany, Israel)? ▪ Which religion is the socio-cultural time period related to (Christianity, Judaism, Islam)? ▪ Which social group is the socio-cultural time period related to (Business Life, Higher Education, Secondary Education)? ▪ Does the socio-cultural time period repeat at regular intervals (has a fixed date)? ▪ Does the socio-cultural time period imply a change in social life, such as general suspension of work or classes? ▪ Is the socio-cultural time period implied by another one (does it have a subordinate concept)?
Applications Using the Ontology	<ul style="list-style-type: none"> ▪ Querying and extracting socio-cultural time periods using the Web query language RDFQL for RDF models ▪ A PROLOG database that includes calendrical information about the extracted time periods. Given a date entry for the Gregorian year 2004 or a duration specification or an origin specification or their various combinations the application delivers the name(s) of the associated socio-cultural time period(s).

Table 6

Ontology Specification Document summarizes the purpose, the scope and the contents of the ontology.

This section has recalled the motivation behind the thesis and specified the purpose and the scope of the Ontology of Socio-Cultural Time Concepts. It has informed that the current ontology corresponds to the conceptual level of the domain and that it covers the meaning

of the expressions modelled in the Ontology of Socio-Cultural Time *Expressions*. The reasons for the necessity of Ontology of Socio-Cultural Time *Concepts* have been explained as well. The subsection has also given an overview about the contents of the ontology. A comparison of the current ontology with the Ontology of Socio-Cultural Time *Expressions* has also been made and the similarities and differences between them have been discussed. More precisely, the purpose of the first ontology is to deliver information about the concepts of socio-cultural time and to justify the need for the Ontology of Socio-Cultural Time *Concepts*. The purpose of the second ontology is to explicate the meaning of the expressions of socio-cultural time, in other words to describe the concepts of socio-cultural time in an unambiguous and precise manner to provide consensus. Therefore, in cases, where a socio-cultural time expression denotes several time concepts (thereby belongs to multiple categories), only one concept has been considered and described in the Ontology of Socio-Cultural Time *Concepts*, where the concept is marked with the sign ‘©’. In this subsection we have also explained that the Ontology of Socio-Cultural Time *Concepts* has the purpose to support temporal systems with additional temporal information (about nations, religions and business life & education), therefore the ontology should deliver the sufficient regular temporal information about each socio-cultural concept entry along with the socio-cultural information. Accordingly, we have stated that several attributes have been defined to fulfil this purpose. Finally, the *Ontology Specification Document* of the Ontology of Socio-Cultural Time *Concepts* has been generated w.r.t. the METHONTOLOGY.

5.3 Conceptualization of the Ontology of Socio-Cultural Time Concepts Related to Nations, Religions, Business Life & Education

This section is devoted to the conceptualization activity of the ontology, where the domain knowledge will be structured in conceptual models. According to METHONTOLOGY, the *conceptualization activity* describes the problem and its solution in terms of the domain vocabulary identified in the *ontology specification activity*. More precisely, in this section we will demonstrate how we used the elements of the ontology defined in the previous section to obtain the Ontology of Socio-Cultural Time *Concepts* as it is now.

Conceptualization activity is composed of several steps. First step is the definition of a *Glossary of Terms*, which is a list of everything that will show up in the ontology. In our case, it is a list of socio-cultural time periods related to nations, religions, business life & education and their associated characteristics.

Second step is the creation of a *Concept Classification Hierarchy*, where the concepts of socio-cultural time periods of the ontology are assigned to appropriate categories and are organized in hierarchical order w.r.t. subclass-superclass relations. We will demonstrate some instance relationships as well.

Third step of the *conceptualization activity* is the building of a *Concept Dictionary*, where detailed information about the categories of the ontology will be delivered. Such information will include for example the category name, its description, its properties, and so forth. Subsequently, a *Binary Relations Table* and *Diagram* will be presented that depicts the property relations in the ontology, which exist with the taxonomic relations simultaneously.

Last step of the *conceptualization activity* is the creation of *Instances Table* that gives information about the instances of the ontology along with their descriptions, associated categories, properties and property values.

In brief, this section will present a formal description of the Ontology of Socio-Cultural Time *Concepts* by defining and documenting the concepts, relations and instances related to the domain of socio-cultural time concepts related to nations, religions, business life & education.

5.3.1 Glossary of Terms

In this subsection, we will present a part of the *Glossary of Terms* for the Ontology of Socio-Cultural Time *Concepts*. As such, the glossary includes all categories, instances, properties that have been used in the ontology and it provides natural language descriptions for each one of them. Regarding the restricted space here we will present only some items defined in the glossary. Appendix A provides for the complete reference.

The purpose of the glossary is to determine the exact contents of the Ontology of Socio-Cultural Time *Concepts*, in other words to decide what the ontology should include and what not. At the same time, it displays a short description of the included items. In short, *Glossary of Terms* is thought as a quick reference to the contents of the ontology. Therefore, the definitions in the *Glossary of Terms* are not highly formal; instead they provide an idea about the general meaning or the function of the related item. An extract of the *Glossary of Terms* is presented in the following table. Left column of the table includes the name of the item, which can comprise a category, a property, or an instance (a concept of time period) and right column includes the associated semi-formal description.

Glossary of Terms

Name	Description
Time Periods	all possible periods of time. e.g. calendar dates, days of weeks, months, hours of days, years, holidays, centuries as well as midnight, yesterday, 1700s, 60ies, medieval ages, lunch-time, weekend, etc.
Calendar Date Periods	periods of time in a given calendar, without socio-cultural characteristics. i.e. calendar days, calendar weeks, months, hours, date. e.g. 12.6.2004, January, 8.00 a.m-12.00 p.m. etc.
Socio-Cultural Time Periods	periods of time that have socio-cultural characteristics i.e. related to a specific religion, a nation or to a social group such as business people or people in higher or secondary education (academia, highschools, etc.) e.g. meeting hours, vacation, semester, easter, memorial day etc.
Socio-Cultural Time Periods that are Related to Nations	periods of time that are specific to some nation. e.g. Thanksgiving Day for USA, Oktoberfest for Germany, Ramadan for Turkey.
Socio-Cultural Time Periods that are One Day Long	periods of time that have socio-cultural characteristics and that have a duration of one day. e.g. Thanksgiving Day for USA, Victory Day for Turkey, All Saints Day for Christianity.
Socio-Cultural Time Periods that are Longer than One Day	periods of time that have socio-cultural characteristics and that have a duration, which is longer than one day, e.g.. Easter, Academic Semester, Weekend etc.
General Suspension of Classes or of Work	it is an indicator whether or not in a given time period classes at university or at high-school will be held or at businesses will be closed.
Similar Time Periods	it indicates the similarity between two separate time periods.
Index	it indicates the position of a time period on the timeline e.g. weekend is the 6 th and 7 th days of the week this the index for Weekend.
Recurrence	it indicates how often a time period repeats, e.g. every year, every day, every six months etc.
Fixed /Variable Calendar Date	it indicates whether a time period can be associated with a given date that never changes or the date associated with it always changes.
Superordination Subordination	it indicates whether a time period implies another time period or is itself implied by another time period.
Martin Luther King's Birthday	a specific day celebrated in the USA , which is associated with the assassination of the US American civil rights fighter Rev. Dr. Martin Luther King.
Intersession	a time period between two academic sessions or terms, when sometimes brief concentrated courses are offered
Ramadan	a time period of one month that is the ninth month of the Islamic calendar, which is the considered as the holy month in the calendar and is devoted to fasting.

Table 7

An extract of the *Glossary of Terms* that includes the names and descriptions of the items used in the ontology that comprise categories, properties and instances

This subsection has provided a partial *Glossary of Terms* for the Ontology of Socio-Cultural Time *Concepts*. The purpose of the glossary is to provide a quick reference for the contents of the ontology by providing short, natural language descriptions of the items. The items or the terms of the glossary are the categories, relations, attributes and instances of

the ontology. The descriptions are semi-formal. As such, the creation of the *Glossary of Terms* constitutes the first step of the *conceptualization activity*. The *Classification Hierarchy*, the *Concept Dictionary* and the *Binary Relations Table and Diagram*, which will be discussed in the next subsections will use the items defined in the *Glossary of Terms*.

5.3.2 Concept Classification Hierarchy

The *Concept Classification Hierarchy* comprises the focus of this subsection and it demonstrates the organization of the categories of the ontology in a hierarchical order w.r.t. subclass-superclass relations.

The classification criteria of the Ontology of Socio-Cultural Time *Concepts* are analogous to the previous ontology. The top level category is (\top). All other categories are subcategories of (\top). Top level category is divided into one subcategory; it is the category of *Time Periods*. This category represents concepts of all possible time periods such as calendar dates, days of weeks, months, and so forth, which can be explicitly anchored on the time line. All other concepts of time periods are not within the scope of the ontology.

Subcategories of one category are at the same level and they have the same criterion of subdivision. To determine the criterion we ask the question at the category *Time Periods* “*Is the time period merely a calendar date time period, or is it a time period that is related to one of the socio-cultural groups specified within the scope of the ontology?*” Time periods that bear no socio-cultural characteristics, in other words that are not related to specific a nation, to a religion or to a specific socio-cultural group, are classified under the category of *Calendar Date Periods*. Remaining time periods do bear socio-cultural characteristics and they qualify as socio-cultural time periods. These comprise the second category, which is the *Socio-Cultural Time Periods*. The two categories constitute the third level of the hierarchy and they are at the same level. Hence, *Calendar Date Periods* and *Socio-Cultural Time Periods* are co-ordinate categories.

Categories are declared as subcategories, supercategories or coordinate categories with respect to their relations to each other in the hierarchy. A subcategory has all the characteristics of its supercategory and at least one further characteristic, which distinguishes it from its co-ordinate categories. Thus, both categories *Calendar Date Periods* and *Socio-Cultural Time Periods* extend the category *Time Periods* with further characteristics. Time concepts that belong to the category *Calendar Date Periods* are necessarily time periods, which are additionally explicit. For example, Lunch-Time, Tomorrow, Last Month cannot be instances of the category *Calendar Date Periods* because they are not explicit. Lunch-Time does not necessarily have to be 12.00 p.m. In order to

determine Tomorrow or Last Month, current day and current month need to be known. In contrast to this, March, Wednesday or 06-05-1976 can be instances of this category because they are explicit. March is always the third month of the year, Wednesday is always the third day of the week and 06-05-1976 is exactly the sixth day of the fifth month of the year 1976 (all w.r.t. Gregorian calendar).

Time concepts that belong to the category *Socio-Cultural Time Periods* are necessarily time periods and they have additionally socio-cultural characteristics. For example, Columbus Day is a time period of one day and it is a US American time concept. Likewise, Yom Kippur is a concept of a time period, which is also one day long and that is related to Jewish religion and Israeli nation.

The category *Calendar Date Periods* is not broken down into any further categories, whereas the category *Socio-Cultural Time Periods* is. Two questions are asked at the category *Socio-Cultural Time Periods* to obtain further subcategories. These questions are “*how long?*” and “*from where?*” The first question targets at extracting information about the *duration* of the time period and the second question targets at extracting the *origin* of the time period. Thus, first question depicts the *temporal* dimension *Socio-Cultural Time Periods* and the second question depicts the *socio-cultural* dimension.

Consequently, further subcategories of the category *Socio-Cultural Time Periods* emerge. These are, *Socio-Cultural Time Periods Related to Nations*, *..Related to Religions*, *..Related to Business Life & Education*, *..Socio-Cultural Time Periods with Duration of One Day*, *...with Duration One of Longer than One Day* and finally *...with Duration of Shorter than One Day*, which are co-ordinate categories.

At this time we arrive at the fourth level of the classification hierarchy and we start to combine the co-ordinate categories in an exhaustive manner. As a result, we obtain the subcategories, which are also co-ordinate categories of each other, such as *Socio-Cultural Time Periods Related to Nations with Duration of One Day*, *..Related to Business Life and Education with Duration of Longer than One Day*, and *..Related to Religions with Duration of Longer than One Day*. These constitute the fifth level of the hierarchy.

Based on the reasons that have been explained before, a particular attention is paid to the nations USA, Turkey, Germany, Israel, to the religions Islam, Christianity, Judaism and to the social groups involving business people and members of secondary and higher education. Therefore, categories concerning the relevant religions, nations and social groups have been defined and they have been subordinated to one of the appropriate combinatory categories defined above. For example, the category of *Turkish Time Periods with Duration of One Day* is subordinated to the category of *Socio-Cultural Time Periods*

Related to Nations with Duration of One Day and the category of *Socio-Cultural Time Periods Related to Higher Education with Duration of Longer than One Day* is subordinated to the category of *Socio-Cultural Time Periods Related to Business Life and Education with Duration of Longer than One Day*. The top level and high levels of the classification hierarchy of the *Ontology of Socio-Cultural Time Concepts* can be represented as:

Top Level and the High Levels of the Ontology

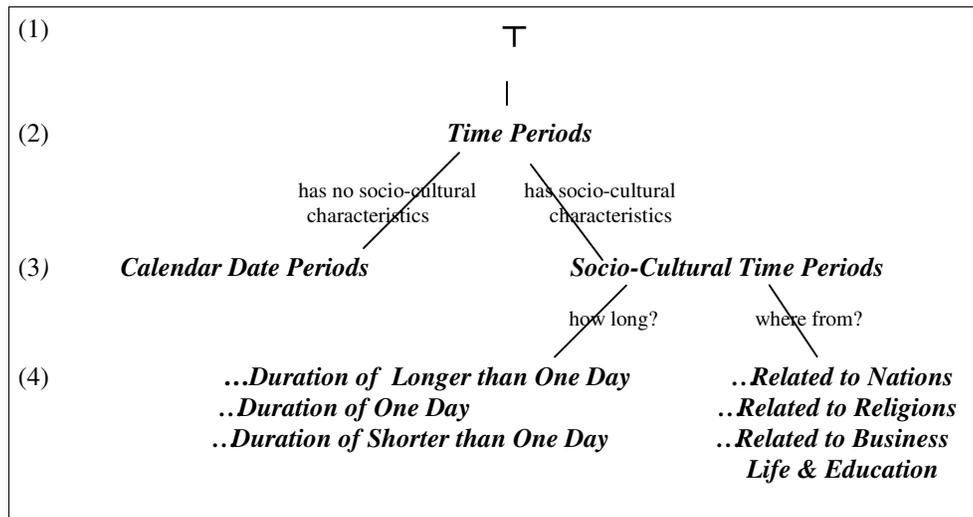


Figure 5

The top level and the high levels of the classification hierarchy w.r.t. subclassOf relationship and classification criteria

In the figure above, (\top) is the top level category, which is subdivided into the category of *Time Periods*. The category of *Time Periods* consists of the two subcategories *Calendar Date Periods* and *Socio-Cultural Time Periods*, which are determined on the basis of given characteristics. The former is not further subdivided, whereas the latter category is broken into further categories. The subcategories of *Socio-Cultural Time Periods* are presented on the fourth level of the hierarchy and they have emerged according to the dimensions of *duration* and *socio-cultural origin*.

Clearly, classification hierarchy can be extended at any level to include further categories. For example, the category *Calendar Date Periods* can be broken down to include finer categories such as *Week Periods* (e.g. the 2nd week of January), *Yearly Quarters and Halves* (e.g. the 4th quarter) or *Year Periods* (e.g. the 60ies, 1920). Likewise, the category *Socio-Cultural Time Periods* can be extended to include finer categories such as *Socio-*

Cultural Time Periods of One Week, ...of Six Months or *Socio-Cultural Time Periods Related to Sports* and so forth.

At the fourth level we start to combine categories of duration and categories of origin in an exhaustive manner so that in the end every possible combination has been realized. Thus, all co-ordinate categories at the fourth level are combined with each other in an exhaustive manner to yield the combination categories at the fifth level. Here are some examples of the combination of categories in the Ontology of Socio-Cultural Time *Concepts*:

Combination Categories

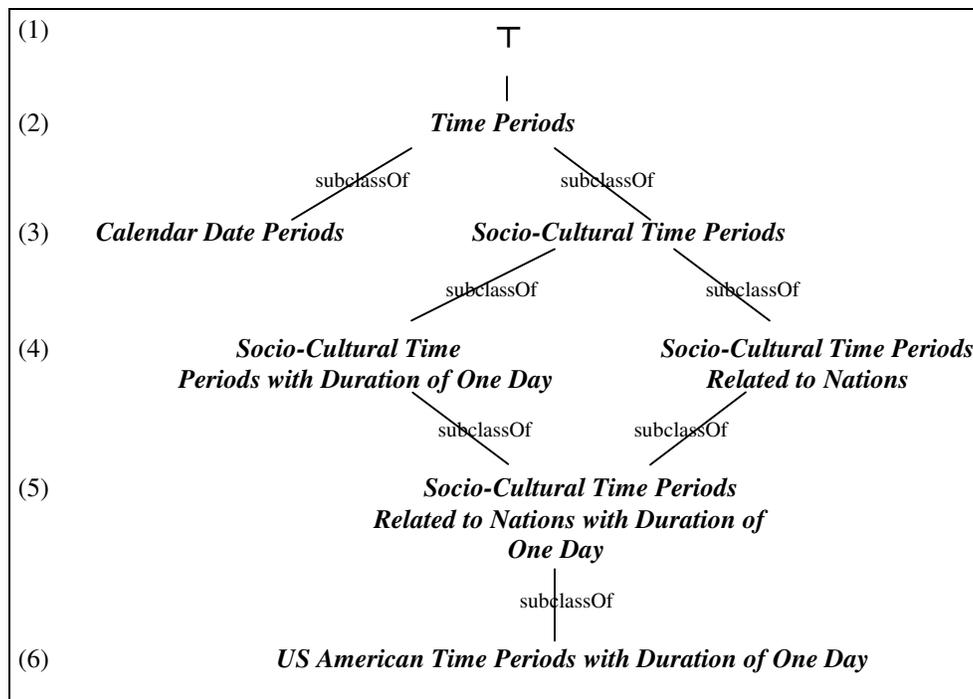


Figure 6

The combination of categories and the subcategory of a combination (intersection) category

Categories related to one specific religion, nation or social group like the Judaism, the Turkish nation or the social group of academia respectively comprise the sixth level of the hierarchy. Each category is subordinated to a relevant category at the fifth level. For example, *Islamic Time Periods with Duration of One Day* is subordinated to the category *Socio-Cultural Time Periods Related to Religions with Duration of One Day*; the category *German Time Periods with Duration of Shorter than One Day* is subordinated to the *Socio-Cultural Time Periods Related to Nations with Duration of Shorter than One Day*.

Categories of the Ontology in the Hierarchical Order

Top Level Category and High-Level Categories	
T	<p>Time Periods</p> <p>Calendar Date Periods</p> <p>Socio-Cultural Time Periods</p> <p><i>Socio-Cultural Time Periods of Business Life and Education</i></p> <p><i>Socio-Cultural Time Periods of Nations</i></p> <p><i>Socio-Cultural Time Periods of Religions</i></p> <p><i>Socio-Cultural Time Periods with Duration of One Day</i></p> <p><i>Socio-Cultural Time Periods with Duration of Longer than One Day</i></p> <p><i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i></p>
One High-Level Category and Its Combination Categories	
	<p>Socio-Cultural Time Periods of Nations</p> <p><i>Socio-Cultural Time Periods of Nations with Duration of Longer than One Day</i></p> <p><i>Turkish Time Periods with Duration of Longer than One Day</i></p> <p>.....</p> <p><i>Socio-Cultural Time Periods of Nations with Duration of Shorter than One Day</i></p> <p><i>Turkish Time Periods with Duration of Shorter than One Day</i></p> <p>.....</p> <p><i>Socio-Cultural Time Periods of Nations with Duration of One Day</i></p> <p><i>Turkish Time Periods with Duration of One Day</i></p> <p>.....</p>
Another High-Level Category and Its Combination Categories	
	<p>Socio-Cultural Time Periods with Duration of One Day</p> <p><i>Socio-Cultural Time Periods of Business Life and Education with Duration of One Day</i></p> <p><i>Socio-Cultural Time Periods of Higher Education with Duration of One Day</i></p> <p>.....</p> <p><i>Socio-Cultural Time Periods of Nations with Duration of One Day</i></p> <p><i>Turkish Time Periods with Duration of One Day</i></p> <p>.....</p> <p><i>Socio-Cultural Time Periods of Religions with Duration of One Day</i></p> <p><i>Christian Time Periods with Duration of One Day</i></p> <p>.....</p>

Table 8

Classification hierarchy of the Ontology of Socio-Cultural Time Concepts

First section of the table above demonstrates the high level categories of the ontology classified according to the criteria *duration* and *origin*. Second and third sections show one of the high level categories of the ontology together with its subcategories, which are combination categories.

Additionally, above examples disclose the graph structure of the classification hierarchy. Due to the structure, it is possible to find an instance of the ontology that is a member of one category starting out from different points in the hierarchy. This aspect is also in accordance with the general design requirements specified for the ontology. Thus, an instance of the category *Socio-Cultural Time Periods Related to Higher Education with*

Duration of One Day can be found either by entering the hierarchy from the category *Socio-Cultural Time Periods with Duration of One Day* or from category *Socio-Cultural Time Periods Related to Business Life and Education*.

In this subsection we have presented the hierarchical organization of the categories (taxonomy) in the Ontology of Socio-Cultural Time *Concepts*. We have pointed out to the identical structure of the current ontology with the Ontology of Socio-Cultural Time *Expressions* and mentioned the classification criteria. The process of combining categories to obtain new categories has also been explained and the graph structure of the classification hierarchy has been underlined. The instances of the categories have not been considered within this subsection, they will be the subject of the forthcoming subsections. Based on the classification hierarchies explained in the current subsection, next subsection will provide a formal description of the categories and will explicate their characteristics and the relations between them.

5.3.3 Concept Dictionary

In this subsection we will provide a formal description of the categories that have been presented in the classification hierarchy of the previous subsection. This process corresponds to the creation of the so-called *Concept Dictionary* according to METHONTOLOGY. Due to space restrictions, only a partial dictionary will be represented, whereby the complete reference can be found at the Appendix B. The formal description includes, for each category, a category name, a brief description of the category, the list of its attributes as well as the list of its associated instances for each category.

Table (9) below demonstrates an extract of the *Concept Dictionary*, which has been defined w.r.t. to the METHONTOLOGY. The leftmost column of the table is reserved for the names of the categories and it includes a number of high level categories of the ontology, which we have presented in the previous subsection. ‘Category Description’ is a formal, human readable description that gives information about the category. ‘Category Properties’ column lists the properties (attributes) that each category carries. ‘Category Instances’ column shows the instances that belong to each category.

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances	Category Relations (subclassOf-superclassOf)
<i>Time Periods</i>	Concept of all possible time periods that can be explicitly anchored on the time line	None	No direct instances	<u>subclassOf</u> (\neg)
<i>Socio-Cultural Time Periods</i>	Concept of time periods related to a specific religion, a nation or to a social group such a business people or people in higher or secondary education	<i>recurrence, has Duration, has Fixed Calendar Date, has Granularity, has Index has Similar Concept, has Subordinate Concept, has Superordinate Concept, has Variable Calendar Date, implies General Suspension of Classes, implies General Suspension of Work</i>	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Nations</i> • ...<i>Related to Religions</i> • ...<i>Related to Business Life & Education</i> • ...<i>Duration of One Day</i> • ...<i>Duration of Longer than One Day</i> • ...<i>Duration of Shorter than One Day</i>
<i>Socio-Cultural Time Periods Related to Religions</i>	Concept of time periods related to some specific religion	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Religions with Duration of Longer than One Day</i> • ...<i>Related to Religions with Duration of One Day</i> • ...<i>Related to Religions with Duration Shorter than One Day</i>
<i>Socio-Cultural Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods having duration that is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Weekend© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Religions with Duration of Longer than One Day</i> • ...<i>Related to Nations with Duration of Longer than One Day</i> • ...<i>Related to Business Life & Education with Duration of Longer than One Day</i>
<i>Socio-Cultural Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that have duration of one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Holiday© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Religions with Duration of One Day</i> • ...<i>Related to Nations with Duration of One Day</i> • ...<i>Related to Business Life & Education with Duration of One Day</i>

Table 9

Concept Dictionary of the Ontology of Socio-Cultural Time *Concepts* depicting the categories, properties, instances and the sub-superclass relationships

The tables above demonstrate an extract of the categories of the Ontology of Socio-Cultural Time *Concepts*. Names of categories and their brief descriptions are provided. ‘Category Properties’ column presents the characteristics of the categories. These properties are defined at the category *Socio-Cultural Time Periods* at the second level of the hierarchy and are inherited to the lower categories of the hierarchy. Therefore, we have listed the attributes only one time at the category *Socio-Cultural Time Periods*.

Concepts of socio-cultural time periods are assigned to the categories of the ontology, so they represent the instances (individuals) of the Ontology of Socio-Cultural Time *Concepts*. Each category necessarily has instances either directly or indirectly. That is, if one category does not have direct instances, then it has instances through its subcategories. For example, in the *Concept Dictionary* above we can see that the category *Socio-Cultural Time Periods* is declared to have “no direct instances”. This does not imply that the category has no instances at all. Its subcategory *Socio-Cultural Time Periods with Duration of One Day* has a direct instance, which is the concept of Holiday©. Hence, the category *Socio-Cultural Time Periods* also has the instance Holiday©, however in an indirect way.

There is a reason why the socio-cultural time concept Holiday shows up with the special sign ‘©’. We have discussed previously that the concept of Holiday demonstrates a problematic case and it will be treated in a special manner. That is, only one meaning of the expression ‘Holiday’ is referred to in the Ontology of Socio -Cultural Time *Concepts*. This is done by classifying the concept Holiday under the category *Socio-Cultural Time Periods with Duration of One Day*. The special sign ‘©’ is attached to the concept to indicate that in the natural language this concept is *not the only one* that is related to the expression ‘Holiday’ but there are also others. For example, those defined in the Merriam Webster’s Dictionary that we have presented previously. Consequently, the *Concept Dictionary* presents the concept Holiday in form of Holiday©. Hence, the following holds for the time concepts in the Ontology of Socio-Cultural Time *Concepts* that come with the special sign ‘©’:

Note:

In the Ontology of Socio-Cultural Time *Concepts*, the special sign ‘©’ is attached to a time concept to indicate that in the natural language this concept is *not the only one* that is related to the expression (i.e. the associated expression is ambiguous). Hence, with the special sign, the meaning of the expression is *standardized*. In other words, *only one* interpretation is determined as the meaning of the expression among others. In the Ontology of Socio-Cultural Time *Expressions*, other associated expressions for the concept can be followed up.

Due to the ambiguous nature of the socio-cultural time expressions, there are more cases in the Ontology of Socio-Cultural Time *Concepts*, where the concepts of time periods are annotated this way. Let us list some of these cases. Appendix C provides for a full reference:

1. Holiday©: In the Ontology of Socio-Cultural Time *Concepts*, the time concept of Holiday© is modelled as a time period that is one day long and that is associated with a special religious observance, or a national celebration, or with a celebration related to a social group, which in some cases indicates a general suspension of work or classes. In the natural language, the expression ‘Holiday’ has various denotations. It may refer to a socio-cultural time period of one day (e.g. Thanksgiving) but it may also refer to a socio-cultural time period of longer than one day (e.g. summer holiday). Moreover, the time period holiday may be determined by a legal authority (e.g. Republic Day) but it may also be determined by the individual person (Vacation).
2. May Day© and Labor Day©: May Day is celebrated on the 1st of May in commemoration of the workers’ rights in most Europe and most other countries. Accordingly, in Germany May Day© is celebrated in this sense and is also referred as Labor Day. In the USA, on the other hand, May Day is celebrated on the 1st of May to welcome the arrival of spring without having any connotation to the workers’ rights. Time concept of Labor Day© in the US American culture is independent of the time concept of May Day© and it is celebrated on the first Monday in September. It marks the end of summer holiday and the beginning of fall. In the natural language expressions ‘May Day’ and ‘Labor Day’ are used interchangeably. In the Ontology of Socio-Cultural Time *Concepts* May Day© is classified under the category *German Time Periods with Duration One Day*. Labor Day© is classified under the category *US American Time Periods with Duration of One Day*.
3. Sabbath©: In our model Sabbath© is considered as an Israeli-Jewish time period that has a duration of one day. In the natural language, the expression ‘Sabbath’ can be used to imply a day reserved for free activities or a certain period of time, when one engages in work activities other than the regular work.
4. Summer School©: A school session conducted in summer enabling students to accelerate progress toward a degree, to make up credits lost through absence or failure, or to round out professional education. In the Ontology of Socio-Cultural Time *Concepts*, Summer School© is associated to higher education and it has duration of three weeks. In the natural language, however, the expression ‘Summer School’ may be used to refer to a time period related to secondary education institutions, language courses or to other educational institutions and may apply various duration.

Finally, ‘Category of Relations’ column gives information about the subclass-superclass relationships between the categories. Accordingly, the category of *Socio-Cultural Time*

Periods is the *subcategory* of the category *Time Periods* and at the same time it is the *supercategory* of the category *Socio-Cultural Time Periods with Duration of One Day*.

In this subsection we have formally described the categories that have been presented in the *Classification Hierarchy* of the previous subsection. In doing so, we have listed the taxonomic relations between the categories, the properties that hold for the categories and some examples of the instances of the categories. All this has been done by means of the *Concept Dictionary* w.r.t. METHONTOLOGY. Furthermore, we have mentioned the special treatment of some instances (that are concepts of time periods) in the ontology. We have given the partial list of these instances and explained the reasons why they have been treated this way.

5.3.4 Binary Relations Table and Diagram

In the Ontology of Socio-Cultural Time *Concepts*, there are several other relations besides the hierarchical relations that relate the categories to each other. In this subsection we will discuss these relations.

Binary relations are represented in form of properties or attributes and they relate one category to the other. Here, we use the term property to refer to these relations. If a category is linked to another category by a property, this means that every instance that belongs to the first category will be related to an instance that belongs to the second category along this property. We can also see this as one property relating a subject to its object.

There are two different kinds of properties. First kind of property relates a category in the hierarchy to another category *in* the hierarchy. Second kind of property relates a category in the hierarchy to another category that is present in the domain of the ontology but that *does not show up in* the hierarchy. That is the category *Literals*. As such, the category *Literals* hold all the string, integer and boolean values of the domain. Thus, the subjects of the second kind of property are instances of the categories in the hierarchy, whereas the objects of the property are arbitrary string, integer or boolean values.

Properties are inherited through the class hierarchy. Thus, every subcategory inherits the properties of its supercategory. Properties in the class hierarchy of the Ontology of Socio-Cultural Time *Concepts* are defined at the category of *Socio-Cultural Time Periods*. Consequently, all its subcategories at the lower levels inherit the properties. Let us give some examples. The property *has Subordinate Concept* is defined at the category *Socio-Cultural Time Periods* and it relates the category to itself. The reason for this is that we want this relation to hold among the instances of the category *Socio-Cultural Time Periods*.

In other words, we want to relate a concept of time period, say Holiday, which is an (indirect) instance of the category *Socio-Cultural Time Periods* to another concept of time period, say Victory Day, which is also an (indirect) instance of the same category such that the first time concept is a superordinate concept of the second one.

To be more concrete, the concept of time period Holiday is a direct instance of the category *Socio-Cultural Time Periods with Duration of One Day*. As this category is a subcategory of *Socio-Cultural Time Periods*, it inherits the property *has Subordinate Concept*. The concept of time period Holiday becomes equipped with this property (because it is the instance of the category of *Socio-Cultural Time Periods with Duration of One Day*). Recall that the property *has Subordinate Concept* is defined at the category of *Socio-Cultural Time Periods* and it relates the category to itself, so the value of the property needs to be another instance of the category *Socio-Cultural Time Periods*. The concept of time period Victory Day is a direct instance of the category *Turkish Time Periods with Duration of One Day*. As this category is the subcategory *Socio-Cultural Time Periods*, concept of time period Victory Day is also an instance of *Socio-Cultural Time Periods*. Hence, the concept of time period Holiday as an instance of the category *Socio-Cultural Time Periods with Duration of One Day* is related to concept of time period Victory Day, along the *has Subordinate Concept* property. The meaning of this relationship can be interpreted as “the concept Holiday implies the concept Victory Day”.

All properties of the ontology relate the instances of the categories in the same way. That is, every instance of the ontology is either related to another instance of a category in the hierarchy or to a string, an integer or a boolean value that is an instance of the category *Literal*. There are eleven different properties, all of which are defined at the category *Socio-Cultural Time Periods*. All subcategories of the category *Socio-Cultural Time Periods* inherit the eleven properties Table (10) shows the properties of the ontology.

Binary Relations (Properties) Table

Category	Property	Property Description	Allowed Property Value
<i>Socio-Cultural Time Periods</i>	<i>has Duration</i>	how long is one time period e.g. 2 days, 5 hours	String
<i>Socio-Cultural Time Periods</i>	<i>has Fixed Calendar Date</i>	time periods, which can always be anchored to the same fraction of the timeline w.r.t. a given calendar	Boolean
<i>Socio-Cultural Time Periods</i>	<i>has Variable Calendar Date</i>	time periods, which cannot always be anchored to the same fraction of the timeline w.r.t. a given calendar	Boolean
<i>Socio-Cultural Time Periods</i>	<i>has Index</i>	when is one time period e.g. "Weekend" has Index '6 th and 7 th days of the week	String
<i>Socio-Cultural Time Periods</i>	<i>has Similar Concept</i>	similarity between time concepts e.g. Carnival <i>has Similar Concept</i> "Mardi Gras"	String
<i>Socio-Cultural Time Periods</i>	<i>has Subordinate Concept</i>	subordinate /superordinate relations between time concepts e.g. Holiday <i>has Subordinate Concept</i> Easter Monday	Instance
<i>Socio-Cultural Time Periods</i>	<i>has Superordinate Concept</i>	subordinate /superordinate relations between time concepts e.g. Easter Monday <i>has Superordinate Concept</i> Holiday	Instance
<i>Socio-Cultural Time Periods</i>	<i>has Granularity</i>	time unit e.g. hour, month, day, year	String
<i>Socio-Cultural Time Periods</i>	<i>recurrence</i>	how often does the time period occur	<u>Fixed Value</u> hourly/ daily/ monthly/ yearly
<i>Socio-Cultural Time Periods</i>	<i>implies General Suspension of Work</i>	time periods that are associated with a change in the usual flow of social life (i.e. periods of time when people do not work)	Boolean
<i>Socio-Cultural Time Periods</i>	<i>implies General Suspension of Classes</i>	time periods that are associated with a change in the usual flow of education life (i.e. periods of time when there is no teaching and no classes are held)	Boolean

Table 10

Properties of the Ontology of Socio-Cultural Time *Concepts*, which relate the categories to each other

Recalling our previous argument, we stated that with the Ontology of Socio-Cultural Time *Concepts* we are not targeting at providing yet another formal description of temporal information. Instead, we want to provide additional information, which is socio-cultural temporal information, to the existing formal temporal information. We outlined how the ontology can support a temporal type system with such additional temporal information and mentioned about the requirement that the ontology needs to provide ways to relate socio-cultural temporal information to regular temporal information. We also indicated the fact

that each socio-cultural time concept that is an instance of the ontology is furnished with several properties in order to fulfil this requirement. These properties are, as the table above shows, *has Duration*, *has Fixed Calendar Date*, *has Variable Calendar Date*, *has Index*, *has Granularity* and *recurrence*. Hence, each instance delivers regular temporal information about itself by means of these properties. Finally, Figure (7) shows a simple diagram that depicts the relationships between categories of the hierarchy:

Binary Relations Diagram

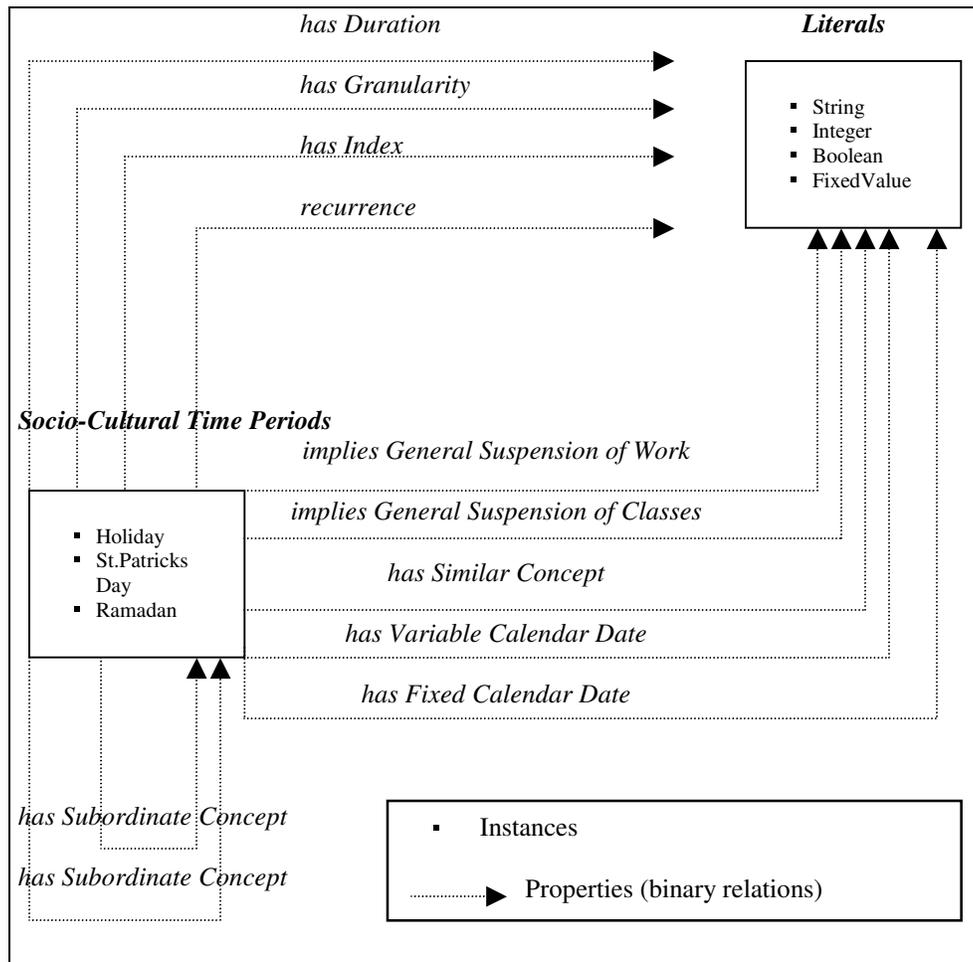


Figure 7

Properties of the category *Socio-Cultural Periods of Time* that relate the instances of the category among each other and to the instances of the category *Literals*

This subsection has given information about the binary relations in the ontology that exist beside the taxonomic relations. We have referred to the binary relations as properties. Properties are defined at the third level of the hierarchy at the category *Socio-Cultural Time Periods* and are inherited to the lower levels. As such, they describe the characteristics of their instances. We have mentioned about two different kinds of properties in the ontology and described their character. A full list of binary relations has been given by means of the *Binary Relations Table*. Finally, the *Binary Relations Diagram* demonstrated the relations that hold between the category *Literals* and the category *Socio-Cultural Time Periods* as well as the binary relations that hold at the category *Socio-Cultural Time Periods* itself.

5.3.4 Instances Table

In this subsection we will provide a description of some instances of the ontology. In doing so, we will give information about the properties and property values of the instances at hand. For full reference please refer to Appendix D.

Time and time again, we have mentioned that the instances of the Ontology of Socio-Cultural Time *Concepts* are the concepts of time periods that necessarily have duration and socio-cultural characteristics. Socio-cultural time concepts such as Feast of Sugar, Lent or July 4th comprise the instances of the ontology. As such, every instance in the ontology is assigned to one and only one appropriate category. For example, Feast of Sugar is a time period longer than a day, which is related to the Turkish culture and which is reserved for the celebration of an Islamic feast. Hence, the time concept of Feast of Sugar is assigned to the category of *Turkish-Islamic Time Periods with Duration of Longer than One Day*. Put another way, the socio-cultural time concept Feast of Sugar has type *Turkish-Islamic Time Periods with Duration of Longer than One Day*.

There are ninety instances in the Ontology of Socio-Cultural Time *Concepts*. Each instance is assigned to a category in the manner described above. Some categories do not have direct instances. In other words, some categories have instances only in terms of the instances of their subcategories. The category *Socio-Cultural Time Periods* is one such example. It has six subcategories, whose instances comprise the instances of the category *Socio-Cultural Time Periods*. Recall that the structure of the hierarchy is a graph (DAG) and one category is allowed to have multiple parents. Thus, it is possible to find an instance (a concept of time period) starting out from different categories. For example, we can find the instance Feast of Sugar following the path: *Socio-Cultural Time Periods* → *Socio-Cultural Time Periods of Religions* → *Socio-Cultural Time Periods Related to Religions with Duration of Longer than One Day* → *Islamic Time Periods with Duration of Longer than One Day* → *Turkish-Islamic Time Period With Duration of Longer than One Day* and finally the instance Feast of Sugar. We can also find the same instance following another path: *Socio-*

Cultural Time Periods → *Socio-Cultural Time Periods Longer than One Day* → *Socio-Cultural Time Periods Related to Religions with Duration of Longer than One Day* → *Islamic Time Periods with Duration of Longer than One Day* → *Turkish-Islamic Time Periods with Duration of Longer than One Day* and finally the instance Feast of Sugar. Table (11) depicts Instances Table w.r.t. METHONTOLOGY.

Instances Table

Instance	Description	AssociatedCategory	Properties	PropertyValues
Oktober-fest	German beer festival in Munich that lasts 16 days	<i>German Time Periods with Duration of Longer than One Day</i>	<i>has Duration</i>	16 days
			<i>has Fixed Calendar Date</i>	FALSE
			<i>has Variable Calendar Date</i>	TRUE
			<i>has Index</i>	3 rd Saturday in September
			<i>has Similar Concept</i>	Wiesn
			<i>has Subordinate Concept</i>	None
			<i>has Superordinate Concept</i>	None
			<i>Has Granularity</i>	day
			<i>recurrence</i>	yearly
			<i>Implies General Suspension Of Work</i>	FALSE
<i>Implies General Suspension of Classes</i>	FALSE			
January-12-2004	Explicit date entry that can be pinned down on the Gregorian calendar	<i>Calendar Date Periods</i>	None	None
Ascension	Christian holiday	<i>Christian Time Periods with Duration of One Day</i>	<i>has Duration</i>	1 day
			<i>has Fixed Calendar Date</i>	FALSE
			<i>has Variable Calendar Date</i>	TRUE
			<i>has Index</i>	Thursday 40 days after Easter
			<i>has Similar Concept</i>	None
			<i>has Subordinate Concept</i>	None
			<i>has Superordinate Concept</i>	Holiday
			<i>has Granularity</i>	day
			<i>recurrence</i>	yearly
			<i>implies General Suspension of Work</i>	TRUE
<i>implies General Suspension of Classes</i>	TRUE			

Table 11

Instances of the ontology with their descriptions, associated categories, properties and the property values

Before proceeding to the implementation of the ontology in OWL, let us provide a summary of the *conceptualization activity*. As of now, we have produced the conceptual structure of the Ontology of Socio-Cultural Time *Concepts*, which is independent of any modelling language and of any platform. In other words, the ontology at this stage, is at the *knowledge level* and it can be implemented using any ontology language.

We have started the *conceptualization activity* by defining a *Glossary of Terms* that includes the socio-cultural time periods related to nations, religions, business life & education and their characteristics. Next, we have created the *Concept Classification Hierarchy*, where the socio-cultural time concepts of the ontology are assigned to appropriate categories and are organized in hierarchical order w.r.t. subclass-superclass relations. Subsequently, a *Concept Dictionary* has been built, where detailed information about the categories of the ontology is delivered. The information includes the category name, its description, its properties, and so forth. After that a *Binary Relations Table and Diagram* has been presented that depict the property relations in the ontology. They exist with the taxonomic relations simultaneously. Finally, the *Instances Table* has been created that gives information about the instances of the ontology along with their descriptions, associated categories, properties and property values. With this final step, we have completed the *conceptualization activity* and produced the ontology at the knowledge level.

5.4 Implementation of the Ontology of Socio-Cultural Time *Concepts* Related to Nations, Religions, Business Life & Education in OWL

This section will introduce how the ontology at the conceptual level has been implemented using the ontology modelling language OWL. In other words, this section shows the mapping of the ontology from the knowledge level to the symbolic level. As mentioned formerly, OWL has been chosen as the implementation language because our ontology is intended for the Web use and OWL is the current Web standard for developing ontologies.

We will refer to the elements of the ontology using the OWL vocabulary. Thus, categories of the ontology are OWL *Classes*, the hierarchical or the taxonomic relationship is the *subclass relationship*. Instances of the ontology are OWL *Individuals*. Binary relations are *properties*, which can be either *Datatype Properties* or *Object Properties*.

Classes are organized in a hierarchical structure w.r.t. *subclass* relationship. Top level category (\top) is the class *Thing*, every class including the system classes, is a subclass of *Thing*. Class *Time Periods* is the subclass of *Thing* and it has two further subclasses, which are the classes *Calendar Date Periods* and *Socio-Cultural Time Periods*. Former does not have any subclasses, whereas the latter does. Class *rdfs:Literal* is the class that holds all the literal values (*Datatype Values*) such as strings, integers and booleans. As such, it is a

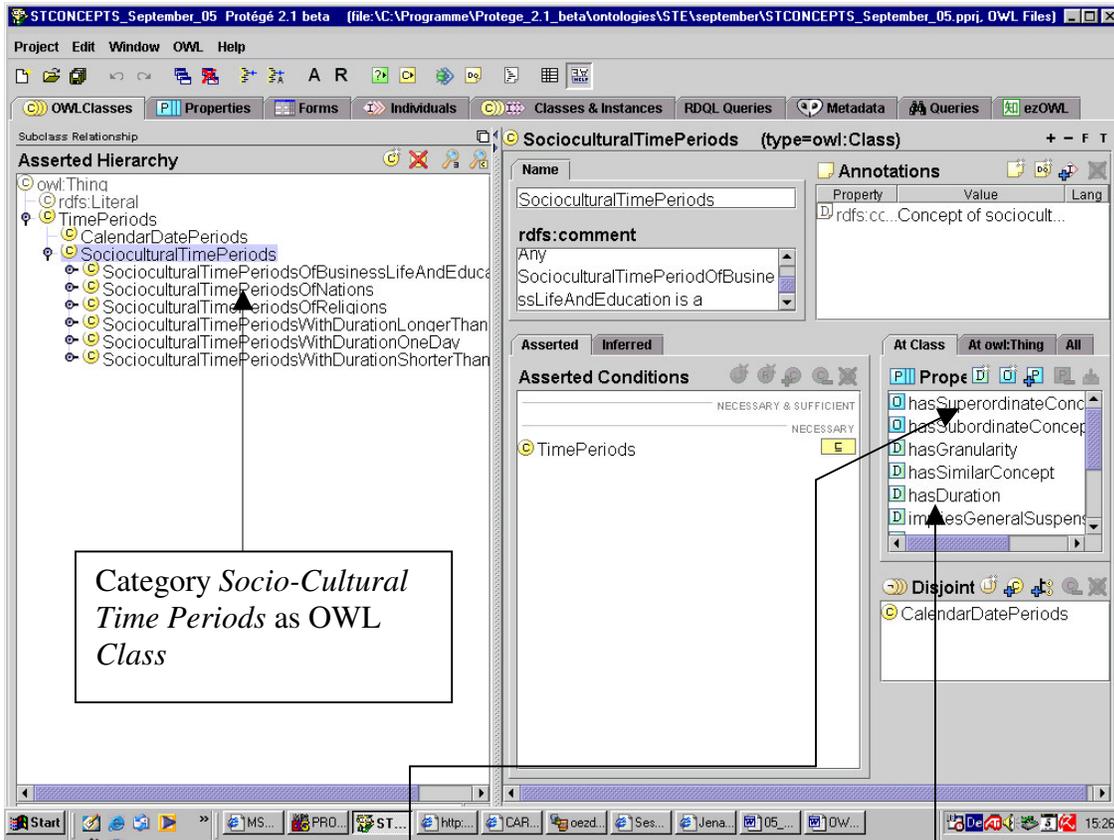
hidden class that does not show up in the actual hierarchy. Classes contain the *Individuals* of the ontology, which are the concepts of time periods.

Properties represent binary relations that hold between the classes of the OWL ontology. There are two types of properties: the *Object Property*, and the *Datatype Property*. In our ontology, first one is a binary relation at the class *Socio-Cultural Time Periods* itself. Thus, an individual that belongs to this class or to one of its subclasses will be related to another individual of this class or an individual of its subclasses along this type of property.

Second property is a binary relation between the class *Socio-Cultural Time Periods* and the class *rdfs:Literal*. Individuals of the class *rdfs:Literal* are *Datatype Values* such as strings, integers and booleans. Thus, the relation links the individuals of the class *Socio-Cultural Time Periods* to arbitrary *Datatype Values* of the class *rdfs:Literal*. This type of property is called *Datatype Property*. Figure (8) shows the top level and the high levels of the hierarchy as well as the *Object-* and the *Datatype Properties* defined at the classes.

Properties have *domains* and *ranges*. This way we can restrict the classes that we want to define the properties for and we can also restrict the values that the properties can take. In our ontology, we have defined the properties only at the class *Socio-Cultural Time Periods*. So, it is the only domain of all properties in the ontology. There are two possibilities for the ranges of the properties. In other words there are two classes in the ontology that can be the range of the defined properties: the class *Socio-Cultural Time Periods* itself or the class *rdfs:Literal*. This means two things: First, the properties can relate the individuals of the *Socio-Cultural Time Periods* to other individuals of the same class (or its subclasses). Second, they can relate the individuals to the *Datatype Values* of the class *rdfs:Literal*. Figure (9) shows the domain and the ranges of the properties.

Finally, Figure (10) shows the *Individuals* of the OWL ontology. The individuals in our ontology are the concepts of time periods. Each class in the OWL ontology has individuals either directly or in terms of its subclasses. Each individual carries the properties of the class it belongs to, thus it is either related to another individual, or to a datatype value or to both along these properties.



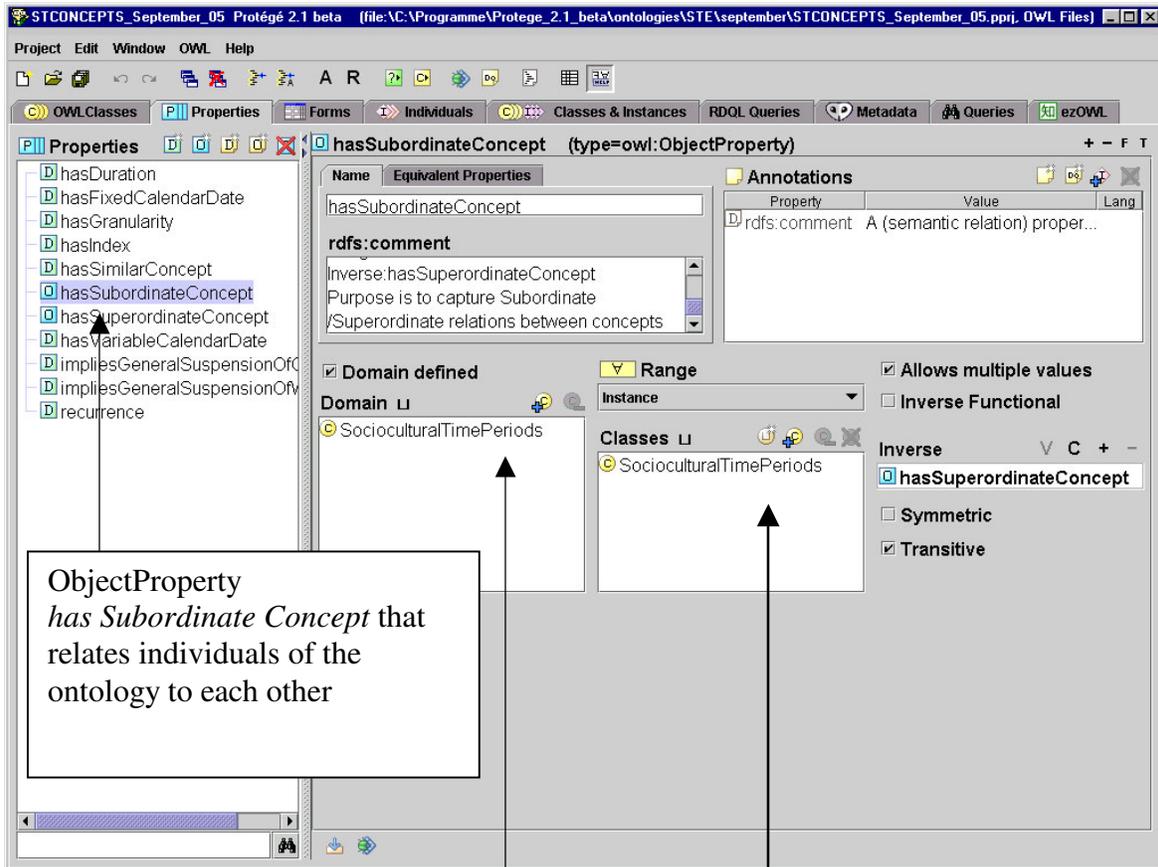
Category Socio-Cultural Time Periods as OWL Class

Figure 8

Categories and properties of the ontology as OWL primitives in Protégé representation

Object Properties defined at the category Socio-Cultural Time Periods

Datatype Properties defined at the category Socio-Cultural Time Periods



ObjectProperty
has Subordinate Concept that
relates individuals of the
ontology to each other

Figure 9

Properties of the ontology as OWL Object- and Datatype Properties in Protégé representation

the *has Subordinate Concept*
property is defined at the class
Socio-Cultural Time Periods.
Thus, this class is the *domain*
of the property.

the *has Subordinate Concept*
property takes the class *Socio-
Cultural Time Periods* as its
value. Thus, this class is the
range of the property.

has Subordinate Concept is an object property that is defined at the
category *Socio-Cultural Time Periods*. The domain and the range of
the category is itself, thus it relates the individuals of the same category
among each other.

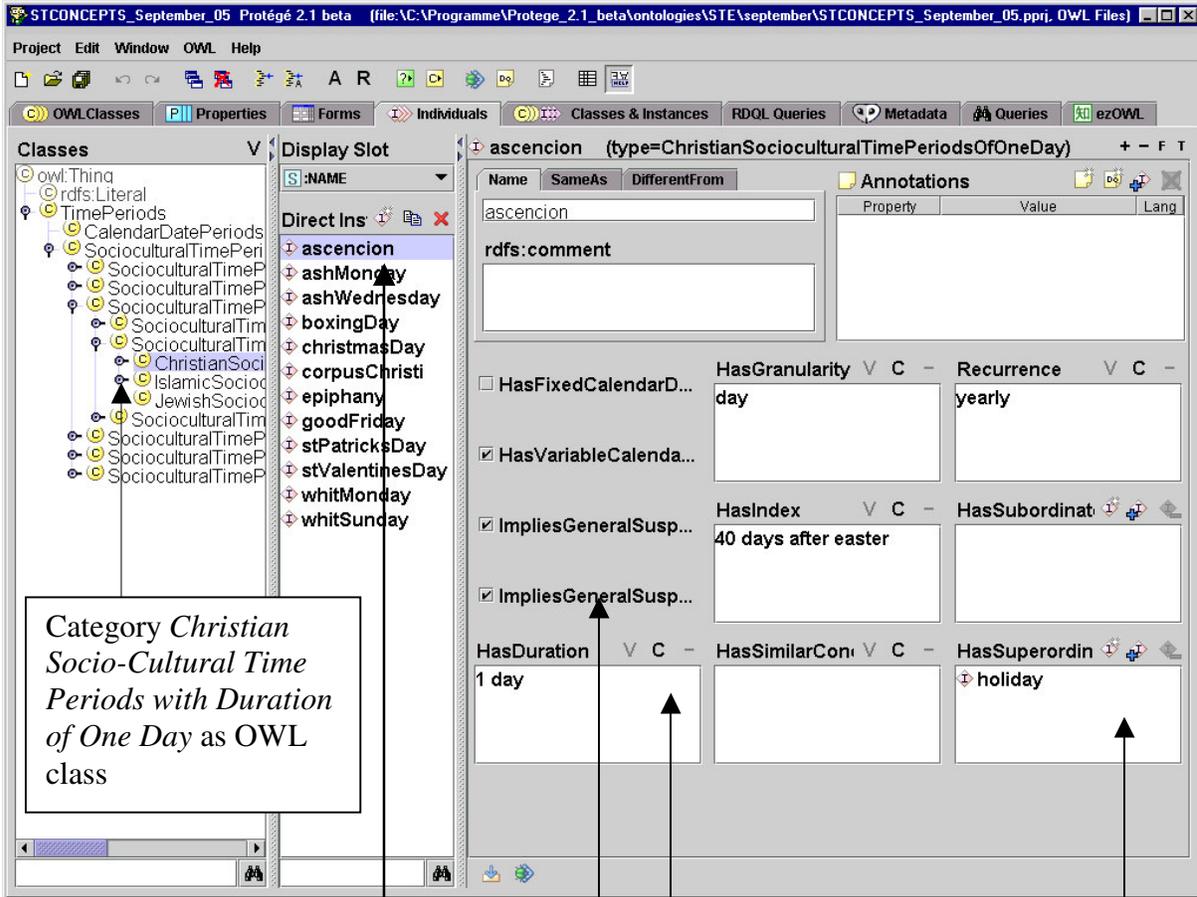


Figure 10

Some instances of the ontology together as OWL individual with their properties and property values in Protégé representation

Instances as OWL Individuals. Here we see the time period Ascension as an individual of the class *Christian Socio-Cultural Time Periods with Duration of*

Datatype Property *has Duration* relates the Individual Ascension to the DatatypeValue "1 day" which is a string.

Datatype Property *implies General Suspension of Work* relates the Individual Ascension to the DatatypeValue TRUE, which is a boolean.

ObjectProperty *has Superordinate Concept* relates Individual Ascension to the Individual Holiday.

We conclude with presenting a piece of OWL code of the Ontology of Socio-Cultural Time Concepts that shows the class *Christian Time Periods with Duration of One Day* and its Individual Ascension represented above. Appendix E provides for the full source code:

Class *Christian Socio-Cultural Time Periods with Duration of One Day*

```
<rdf:RDF
  xmlns:rss=http://purl.org/rss/1.0/
  xmlns:jms=http://jena.hpl.hp.com/2003/08/jms#
  .....>
<owl:Ontology rdf:about=""/>
<owl:Class rdf:ID="TimePeriods">
  .....
<owl:Class rdf:ID="ChristianSocio-CulturalTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#Socio-
      CulturalTimePeriodsOfReligionsWithDurationOfOneDay"/>
  </rdfs:subClassOf>
</owl:Class>
```

Table 12

Category *Christian Socio-Cultural Time Periods with Duration of One Day* as OWL Class

Individual Ascension

```
<ChristianSocio-CulturalTimePeriodsOfOneDay rdf:ID="ascencion">
<impliesGeneralSuspensionOfClasses
  rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean"> true
</impliesGeneralSuspensionOfClasses>
<hasSuperordinateConcept rdf:resource="#holiday"/>
<impliesGeneralSuspensionOfWork
  rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean"> true
</impliesGeneralSuspensionOfWork>
<hasVariableCalendarDate
  rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean"> true
</hasVariableCalendarDate>
<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day
</hasDuration>
<hasGranularity
  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day
</hasGranularity>
<hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string"> 40 days
after easter </hasIndex>
<recurrence>yearly</recurrence>
</ChristianSocio-CulturalTimePeriodsOfOneDay>
```

Table 13

Representation of the instance Ascension as an OWL Individual

This section has demonstrated how the ontology at the conceptual level has been implemented using the ontology modelling language OWL. Within the scope the section, we have first introduced the primitives of the OWL language such as classes, properties and individuals to represent the elements of the ontology such as categories, binary relations and instances, respectively. Next, we have shown the components of the ontology explicitly by taking aid from the ontology editor Protégé. Finally, we have provided a piece of OWL code that shows an implemented class and its individual in OWL.

5.5 Applications

In this section we are going to discuss the application areas of the Ontology of Socio-Cultural Time *Concepts*. The first subsection is devoted to an already realized application. As such, this application is thought to form the foundations of a socio-cultural calendar. Such a calendar can be referred by users as an information resource. Additionally, it can aid a temporal Web application system such as a Web based automated appointment scheduling service we have mentioned formerly. Second application, is a possible application more in the form of a future scenario. It describes how a Web based automated appointment scheduling system can provide socio-cultural context aware service by reading the Web pages that are semantically annotated by the socio-cultural time ontology. Please acknowledge that both applications consider the Gregorian calendar.

5.5.1 Realized Applications: Foundation of a Socio-Cultural Calendar

In this subsection we describe the foundation of a socio-cultural calendar that bases itself on the information provided in the Ontology of Socio-Cultural Time *Concepts*. In doing so, we are going to outline the steps we have taken for the realization of the application.

To begin with, we have extracted some instances from the ontology. This can be done by using a query language called RDFQL²⁸ (RDF Data Query Language), which has been implemented in a number of RDF systems for extracting information from RDF models. W3C states that every valid OWL model is an RDF model, therefore it possible to apply RDF technologies to OWL models. In order to be able to query the OWL ontology, it first needs to be uploaded to a so-called RDF repository, that supports query facilities. For this purpose, we have chosen the Sesame RDF Storage²⁹ repository from the openRDF.org.³⁰ Once the model is uploaded to the repository, it can be processed online by several query languages including the RDFQL.

²⁸ <http://www.w3.org/Submission/2004/SUBM-RDQL-20040109/>

²⁹ <http://www.openrdf.org/sesame/actionFrameset.jsp?repository>

³⁰ <http://www.openrdf.org/index.jsp>

Table (14) shows the conducted queries and the results as extracted instances that are concepts of socio-cultural time periods:

Querying and Extraction of Time Periods

Query: SELECT ?timeperiod, ?recurrence WHERE (?timeperiod, <http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#recurrence>, ?recurrence)	
Query results:	
timeperiod	recurrence
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#oktoberfest	“yearly”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#rushHour	“daily”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#sabbath	“weekly”
Query: SELECT ?timeperiod, ?impliesGeneralSuspensionOfWork WHERE (?timeperiod, <http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl #impliesGeneralSuspensionOfWork>, ?impliesGeneralSuspensionOfWork)	
Query results	
timeperiod	implies General Suspension of Work
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#purim	“true”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#july4th	“true “
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#goodFriday	“true”
Query: SELECT ?timeperiod, ?similarTimeConcept WHERE (?timeperiod, <http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#hasSimilarTimeConcept>, ?similarTimeConcept)	
Query results	
timeperiod	similarTime Concept
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#mayDay	“workers day”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#july4th	“independence day”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#oktoberfest	“wiesn”
http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#pessah	“passover”

Table 14

Examples of socio-cultural time periods as instances of the ontology that have daily, weekly or yearly recurrence, that imply general suspension of work or that are similar in meaning

As next, we have used these instances and some more others, to develop an application, which can serve as a socio-cultural calendar for the Gregorian year 2004 provided that it is visualized. More concretely, this application is a small PROLOG database, which includes a subset of the socio-cultural time concepts of the model. All calendrical information for the year 2004 about the socio-cultural time periods is encoded as simple PROLOG facts and rules. Please refer to Appendix F for the full source code of the PROLOG application. The program takes a granularity, duration, a date or an origin or all of these specifications and returns the associated socio-cultural time concept or time concepts. For example:

Simple PROLOG Goals for Concepts of Socio-Cultural Time Periods

```

?- christian(X), german(X).
X = ernteDankTag ;
X = fasching ;
No

?- october_31(X).
X = halloween ;
No

?- oneDay(X).
X = stValentinesDay ;
X = halloween ;
X = fasching ;
X = ataturkYouthAndCommemorationDay ;
X = ernteDankTag ;
X = purim ;
X = mayDay ;
X = goodFriday ;
X = july4th_independenceDay ;
No

?- day(X), oneDay(X), christian(X), february_14(X).
X = stValentinesDay ;
No

```

Table 15

A small PROLOG program that takes socio-cultural origin or date or duration or granularity + duration + origin + date and returns the associated socio-cultural time concept

Thus, on the basis of this program, we can get information about, for example, time periods, which are Jewish days, US American weeks, or Islamic months as well as Christian time periods that are two days long, etc. We can also find out what time period is implied by a given date entry. We have the following possible picture in mind for such an application:

The Socio-Cultural Calendar

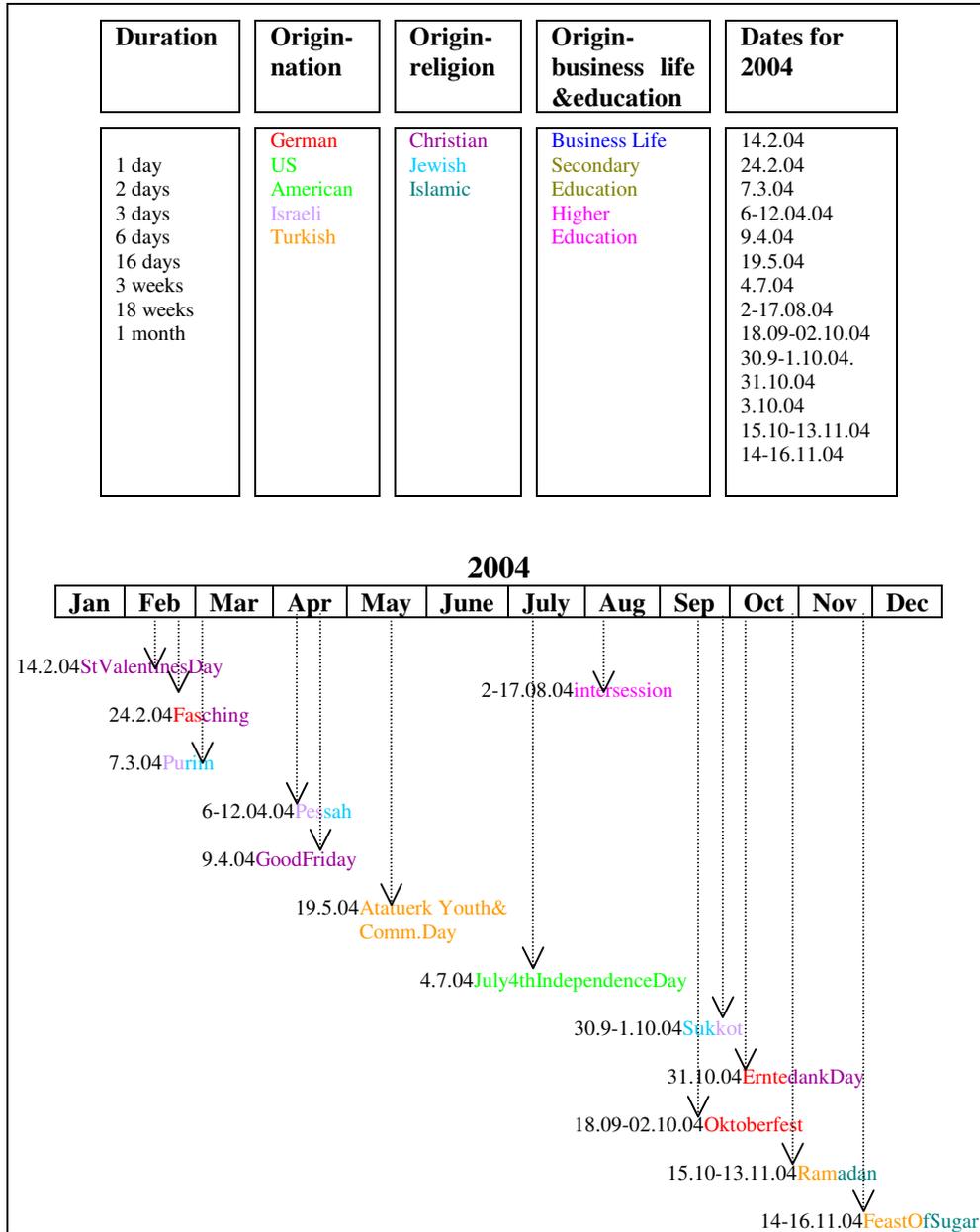


Figure 11

Possible visualization of the Socio-Cultural Calendar. The associated types of socio-cultural time periods are indicated by colors

Finally, calendrical information is entered manually into the PROLOG database, however if the ontology would be integrated into a temporal type system such as the one in [80], all the calculations can be performed automatically.

In this subsection we have first demonstrated how we have conducted queries on the Ontology of Socio-Cultural Time *Concepts* using the RDF query language RDFQL. As a result we have extracted some instances of the ontology, which are concepts of socio-cultural time periods. Second, we have used the extracted instances together with some other instances to provide the foundation of a socio-cultural calendar. For this, we have designed a small PROLOG database consisting of the related instances.

5.5.2 Possible Applications: Scheduling an International Appointment via the Web

In this subsection we will describe a real world scenario for a possible application of the Ontology of Socio-Cultural Time *Concepts*. The scenario illustrates how a Web based automated appointment scheduler can deploy the socio-cultural time ontology to reason about the possible different time conceptions of the parties involved in the appointment scheduling process.

Problem:

Andrea, a businesswoman from Munich, Germany, is planning a business trip to Istanbul, Turkey in the first two weeks of September 2004. During this time she wishes to have several meetings with her clients in Istanbul. Andrea wants to know:

- Are there any holidays in Turkey in September during which offices and banks are closed? Andrea may need to draw money and make payments; therefore it is important for her that during the time she is there, there is no general suspension of work.
- When is weekend in Turkey? Is it also Saturday and Sunday like in Germany? Andrea wants to be sure whether or not she can work on Saturday.
- Which day is the religious day of the week in Turkey? Andrea wants to be considerate about the religious customs of her clients. If she knows the religion of Turkish culture and the religious day, then she can pay attention not to schedule business meetings on that day.
- Finally, Andrea herself would also rather have no appointments on Sunday as she would love to experience a Sunday service at a church in Istanbul.

Now, being very busy as she is, Andrea does not have time for a series of phone calls and organizations to arrange the suitable appointments with her clients. Moreover, her clients are as busy as she is, therefore she presumes they would also rather avoid long phone calls and emails.

Solution:

Andrea uses a Web based automated appointment scheduling service that is provided by some service provider on the Web. The service assigns Andrea a calendar agent similar to the *Retsina Semantic Web Calendar Agent* from the Robotics Lab. of Carnegie Mellon University, which we have mentioned before.

Andrea informs the calendar agent about all her preferences we have discussed above. Thereupon, the agent starts to look for Web pages that contain events, happenings, holidays and intercultural background information about Turkey in particular about Istanbul.

The calendar agent is able to read RDF models. As W3C states every OWL model is an RDF model, therefore the agent is able to read OWL models as well. Soon, it starts to find the pages that contain information about events and cultural background information about Turkey and Istanbul because these pages are annotated with the RDF individuals or the RDF semantic-tags of the *Ontology of Socio-Cultural Time Concepts*. The agent additionally has an intern socio-cultural calendar component, for a given year and a given calendar (here Gregorian calendar) in order to verify the validity of the data it collects. This can be a socio-cultural calendar like the one we have outlined in the previous subsection.

Now that the calendar agent found sufficient information, and has verified the information, it starts to reason. On the basis of the of the RDF tags that refer to the socio-cultural time ontology, which is already published on the Web, the agent can infer that in September there are no holidays in Turkey that imply general suspension of work, so banks and businesses remain open during the week. Besides, Turkish weekend is Saturday and Sunday officially in Turkey, which is same as in Germany. However, as Turkey's religion is Islam, the religious day is a day called Juma, which is the similar time concept of Friday. Having acquired and inferred all this information, Andrea's calendar agent looks again to the preferences about her desired appointments and organizes them accordingly. That is, all weekdays are available for banking activities, no meetings on Friday and no meetings on Sunday. When this is done, the calendar agent imports all the scheduling information to Andrea's organizer e.g. the Outlook.

As a final step Andrea's calendar agent starts to negotiate with the calendar agents of her clients to learn about their preferences and availabilities for the month September. The clients' calendar agents have gone through the same process, thus they are aware of the fact that the time concept of Weekend in Germany is the same as in Turkey, however the religious day in Germany is Sunday. Thus, the agents infer that the probability of having an appointment with Andrea on Sunday is low. Finally, all what Andrea needs to do is to look at her Outlook organizer and buy an appropriate plane ticket.

Support of the Socio-Cultural Time Ontology: The ontology supports the Web based appointment scheduling service in two ways: First, the calendar agent of the service uses the Web pages that are semantically annotated by the ontology, whereby it infers knowledge referring to ontology published on the Web. Second, the agent refers to the socio-cultural calendar component of the service, to verify the data w.r.t. the given year. Socio-Cultural calendar includes all the socio-cultural time information provided in the ontology and the associated date entries of the relevant calendar year.

In this subsection we have described a scenario for a possible application of the Ontology of Socio-cultural Time *Concepts*. The scenario described how the calendar agent of a Web based automated appointment scheduling service can use the Web pages annotated by our ontology to infer knowledge about culture-specific time conceptions. This way, the service can react more sensitively against the culture specific preferences of the parties involved in the appointment scheduling process.

Before proceeding to the Conclusions, let us summarize this chapter. This chapter has demonstrated the achievement of the second goal of this thesis. As such, the chapter has described the two ontologies that have been developed for a formal representation of socio-cultural time. First ontology is the Ontology of Socio-Cultural Time *Expressions* and it provides information about socio-cultural time at the lexical level. We have described the role and the overall structure of this ontology and stated that it acts as a justifier for the second ontology. Second ontology is the Ontology of Socio-Cultural Time *Concepts*, which delivers socio-cultural temporal information at the conceptual level. We have described the development stages of the second ontology in detail w.r.t. METHONTOLOGY.

First we have stated the purpose and the scope of the ontology and generated the *Ontology Specification Document*.

Second we have explained the *conceptualization activity* by means of exhibiting the *Glossary of Terms*, the *Concept Classification Hierarchies*, the *Concept Dictionary*, the *Binary Relations Table and Diagram* and finally the *Instances Table*. At the end of this second step we have produced the ontology at the knowledge level.

Third, we have shown the OWL implementation of the ontology.

Last section of the chapter has exhibited the applications that use and that may use the ontology. The ontology has been used concretely by the RDFQL query language to extract desired instances from the ontology. Subsequently, the extracted instances have been used to implement a PROLOG database that delivers temporal information about the instances w.r.t. Gregorian calendar for the year 2004. Such a calendar can comprise a component of a Web based automated appointment scheduler to verify its data. The possible application scenario has described how such a Web based appointment scheduling service can make use of the ontology.

6 Conclusions

This thesis has first provided a brief survey about ontological engineering by mentioning the aggregates of the field and by reporting the latest progressions as well as the current pitfalls. As such, this survey can be used as a brief reference for today's ontological engineering. In addition, it can aid the development of an ontology by means of providing information about suggested methodologies, ontology libraries, languages, editors and examples of current ontologies.

Second, this thesis has pointed out to the need for an ontology of socio-cultural time that formally describes the different time conceptions of various cultures and social groups. Subsequently, the thesis has described the characteristics of the two ontologies that have been developed with the aim to answer the need. In particular, the *Ontology of Socio-Cultural Time Expressions Related to Nations, Religions, Business Life & Education* and the *Ontology of Socio-Cultural Time Concepts Related to Nations, Religions, Business Life & Education* have been described, whereby the latter has comprised the core of the thesis.

The *Ontology of Socio-Cultural Time Concepts* can be used in several applications. It can provide semantic annotation for the Web pages, it can be integrated into a temporal type system to enable calendrical calculations about socio-cultural time and finally it can support a Web based automated appointment scheduling service. In the last chapter, we have discussed the means for the realization of these applications.

The following two subsections will both report the results of this thesis and will point out to the future research issues, which necessarily arise from the given results.

6.1 Results

We have partitioned the domain of socio-cultural time related to nations, religions business life & education into two levels, which are the lexical level and the conceptual level and for each level we have developed a separate ontology from scratch. This approach is along the same lines with those suggested by the NLP ontologists as discussed in [11],[12] and [13],[14].

Most current temporal and cultural ontologies, e.g. [48],[58],[39] are large projects that have been developed with different intentions in mind. Some temporal ontologies constitute a part of a far larger ontology, e.g. Cyc. Therefore, it has not been possible to reuse these in the development process of our two ontologies. Current technologies in ontological engineering, only allow the reuse of entire ontologies. That is, it is not yet possible to efficiently extract the relevant components of one ontology and plug them in another

ontology. Therefore, it has not been possible either to reuse the relevant components of the ontologies we have mentioned above.

The two ontologies need to be extended in terms of their contents and in terms of the scope of the domain to be more representative. Both ontologies provide declarative knowledge only about a subset of the domain of socio-cultural time (i.e related to nations, religions, business life & education), which could be extended to include further socio-cultural groups such as sports, healthcare or others. The focal ontology, which is the Ontology of Socio-Cultural Time *Concepts*, can be primarily filled with more socio-cultural temporal data to upgrade it to a status of a more comprehensive knowledge base.

Currently, the temporal information provided in the ontology of Socio-Cultural Time *Concepts* solely concerns Gregorian calendar. In order to become more socio-cultural context sensitive, it requires information about other calendars such as the Islamic or the Hebrew calendar.

Reasoning about the ontology can only be done by means of external reasoning mechanisms. We have discussed the two current reasoning mechanisms that provide this service.

To conduct calendrical calculations about the time periods defined in the Ontology of Socio-Cultural Time *Concepts*, the ontology essentially needs to be connected to a temporal type system. Consequently, we have referred to a (socio-cultural context-sensitive) temporal type system called *Towards a Multi-Calendar Temporal Type System for (Semantic) Web Query Languages* in [80].

With the Ontology of Socio-Cultural Time *Expressions* we have referred to the area of Natural Language Processing (NLP) and ontologies, which we discussed in Chapter 3. Based on the fact that our motivation is not linguistic, we have not delved into the details of the expressions of socio-cultural time. We have merely stated the fact that the expressions of socio-cultural time, being a subset of natural language expressions, are not adequate for an unambiguous and systematic description of the domain because they are naturally vague. This issue needs to be referred to in more detail, so that the ontologies can provide linguistic support about the domain of socio-cultural time related to nations, religions, business life & education.

Currently, there are two concrete applications that use the Ontology of Socio-Cultural Time *Concepts*. For the first application we have uploaded the ontology to an ontology repository on the Web that supports query facilities. This enables the ontology to be accessed and processed online. Using the RDF query language RDFQL we have queried and extracted

some instances of the ontology, for example the similar socio-cultural time periods or socio-cultural time periods that imply a general suspension of work.

Regarding the second application, we have used the extracted instances along with the others, to implement a small database in PROLOG that includes calendrical information about these time periods for the year 2004. If a calendar date in 2004, or duration, or an origin, or all of these specifications together are given to the PROLOG program, it delivers the associated socio-cultural time period. As such, we consider this application as the foundation of a socio-cultural calendar, which has been picturized.

Finally, we have illustrated a real world scenario as a possible future application for the Ontology of Socio-Cultural Time *Concepts*. The scenario concerns the issue of a Web based appointment scheduling process, which requires information about the socio-cultural context of the parties involved in the process. With this information, the Web-based appointment scheduling service can react in a more context sensitive manner to the culture specific temporal preferences of its users. We have reported that work is in progress for such Web-based automated appointment schedulers, for example the Carnegie Mellon University's *Retsina Calendar Web Agent*. Such an application can use the ontology in order to extend its temporal information to include socio-cultural temporal information about the given nations, religions, business life and education.

6.2 Future Work

As a result of this thesis we have identified several research issues that require further investigation. Future investigations concern both ontologies, which have been developed within the scope of this thesis, however they will tackle different problems.

First ontology, which is the Ontology of Socio-Cultural Time *Expressions*, does not provide the right means for a systematic explicit and unambiguous description of socio-cultural time to support a temporal Web application system because of the previously discussed reasons. However, this does not imply that there can be no marriage between ontologies and natural language expressions. On the contrary, ontologies have started to become very popular in the Natural Language Processing area and as Bateman states [11],[12] today's ontologists should by no means disregard the role of natural language in modelling knowledge about the real world. Parallels, a group of terminologists and datalinguists [13],[14] are working on systems that map conceptual data to lexical data with the objective of acquiring meaning and providing terminological consensus without being trapped by the ambiguity of natural language expressions.

Clearly, the Ontology of Socio-Cultural Time *Expressions* needs more attention in this direction. With a linguistic motivation, efficient methodologies can be sought for to map between the Ontology of Socio-Cultural Time *Expressions* and Ontology of Socio-Cultural Time *Concepts*.

A systematics for (semi)automatic extraction of socio-cultural time expressions is necessary. Acquisition of information about socio-cultural time expressions has been a highly time consuming procedure. Since such conceptions are mostly implicitly present, the information needs to be assembled from a variety of resources such as books, newspapers, the Web, human conversations, media and so forth. When searching for socio-cultural time expressions denoting time periods on the Web, we have used the following query pattern: “subject matter” + “calendar”. For example, “medical calendar”, “Turkish calendar”, “Jewish calendar” etc. In most of the cases this query pattern returned satisfactory results. We have retrieved pages that contain dates relevant to the subject matter such as various important dates in 2004 for Jewish religion. The surroundings of the date entries in the retrieved pages usually contained the necessary expressions, such as “Pessah”, “Passover”, “Jewish New Year”, etc. On the basis of this experience, information retrieval and information extraction methods can be investigated to retrieve Web pages matching the query pattern above and to extract the expressions in the surroundings of date entries, month names or in the surroundings of certain words such as the word “holiday”.

Finally, language support is necessary for the ontology. Currently, the ontology is conceptualized and implemented in the English language. However, due to the nature of the domain, the ontology refers to a variety of developers and users, who come from different socio-cultural contexts and who speak various languages. The ontology can be translated into other languages to increase user convenience.

REFERENCES

- [1] *Opuscles et fragments in edits de Leibniz*, 1903, p. 512. From Louis Couturat. In *Descriptive and Formal Ontology* by Raul Corazzon http://www.formalontology.it/site_map.htm 08/29/2004
- [2] Kiryakov, B. Popov, D. Ognyanoff, D. Manov, A. Kirilov, M. Goranov. *Semantic Annotation, Indexing, and Retrieval*, Volume 2870 of Lecture Notes in Computer Science. Springer, 2003
- [3] J.P. Sierra, A.P. Sierra, A. Gómez Pérez, M. Fernández López. *Building a Chemical Ontology Using METHONTOLOGY and the Ontology Design Environment*. IEEE Intelligent Systems, 1999.
- [4] O. Corcho, A. Gómez Pérez. *Ontology Specification Languages for The Semantic Web*, IEEE Intelligent Systems, 17(1) 2002, pp. 54--60.
- [5] O. Corcho, A. Gómez Pérez, M. Fernández López. *Ontological Engineering*. In *Advanced Information and Knowledge Processing*. Springer-Verlag 2004, pp 1--60.
- [6] E. Abou-Zeid. *Towards a Cultural Ontology for Interorganizational Knowledge Processes*. In *Proc. of 36th Hawaii International Conference on System Sciences HICSS-36*, January 6-9 Big Island HI, IEEE Computer Society, pp. 4--9.
- [7] M. Agnesund. *Representing Culture-Specific Knowledge in a Multilingual Ontology*. In Agnesund, M. 1997. *Representing Culture-Specific Knowledge in a MultilingualOntology*. In *Proceedings of The IJCAI-97 Workshop on Ontologies and Multilingual NLP*, 1997.
- [8] J. Allen. *Maintaining Knowledge about Temporal Intervals*. *Communications of the ACM*, 1983.
- [9] G. Antoniou, F. van Harmelen. *Semantic Web Primer*. In *Cooperative Information Systems*. MIT Press Cambridge, April 2004
- [10] C. Welty, B. Smith. *Fois Introduction: Ontology and Information Systems- Towards a New Synthesis*. In *Proc. of Formal Ontology International Conference on Formal Ontology in Information Systems*, Ogunquit, Maine, USA, ACM Press NY 2001, pp. 3--9

- [11] J.A. Bateman. *The Theoretical Status of Ontologies in Natural Language Processing* In Susanne Preuss and Birte Scmitz (eds.) *Text Representation and Domain -Modelling Ideas from Linguistics and AI*. KIT Report-97 Technische Universität Berlin, May 1992, pp. 50-99. (papers from KIT-FAST Workshop, Technical University Berlin, October 9th –11th 1991)
- [12] J.A. Bateman. *On the Relationship between Ontology Construction and Natural Language: A Socio-Semiotic View*. *International Journal of Human-Computer Studies*, 43(5/6) 1995, pp. 929--944.
- [13] J. De Beule. *Creating Temporal Categories for an Ontology of Time*. In *Proc. of CLIN 2003 14th Meeting of Computational Linguistics in The Netherlands*, 19 December Antwerpen, Belgium, 2003.
- [14] C. Vikner, B.N. Madsen, H.E. Thomsen. *Data Modelling and Conceptual Modelling the Domain of Terminology*. In A. Melby, (ed.), *Proc. of TKE 2nd Terminology and Knowledge Engineering*, INRIA Frankrig 26-28 May 2002, pp.59--68.
- [15] C. Vikner, B.N. Madsen, H.E. Thomsen. *Principles of a System for Terminological Concept Modelling*. In *Proc. of 4th International Conference on Language Resources and Evaluation*, LREC 26-28 Lisbon Portugal, May 2004, pp.
- [16] N.F. Noy, C.D. Hafner. *The State of the Art in Ontology Design: A Survey and Comparative Review*. *AI Magazine*, Fall 97, pp.53--74.
- [17] P. Constantopoulos. *Cultural Documentation in the CLIO System*. tech. report TR94-0115, tech. report 115, ICS-FORTH, Heraklion Crete, Greece, January 1994. <http://citeseer.ist.psu.edu/constantopoulos94cultural.html>
- [18] Horrocks, D.L. McGuinness, P.F. Patel-Schneider, L.A. Stein, D. Connolly, F. van Harmelen. *Daml+OIL Reference Description*. tech. report, World Wide Web Consortium (W3C) 18 December 2001 <http://www.w3.org/TR/daml+oil-reference>
- [19] H. Lieberman, W. Wahlster, D. Fensel, J. Hendler. *Spinning the Semantic Web*. MIT Press Cambridge, 2003.
- [20] T.J.M. Bench-Capon, P.R.S. Visse, D. Jones, M. Jones. *Methodologies for Ontology Development*. In *Proc. ITKNOWS Conference of the 15th IFIP World Computer Congress*, Budapest, Chapman-Hall., 1998, pp. 2--8.

- [21] M. Doerr. *Mapping of the Dublin Core Metadata Element Set to the CIDOC CRM*. tech. report 274, July 2000.
- [22] G. Englebretsen. *A Reintroduction to Sommers' Tree Theory*, Chapter 1 of: *Essays on the Philosophy of Fred Sommers--Lewiston*, the Edwin Mellen Press, 1990, p. 5.
- [23] D. M. Guinness, D. Nardi, P. Patel-Schneider, F. Baader, D. Calvanese, (ed.) *The Description Logic Handbook Theory, Implementation and Applications*. Cambridge University Press, 2003.
- [24] E. Miller, F. Manola. *RDF Primer*. tech. report, World Wide Web Consortium (W3C) Recommendation 10 February 2004, <http://www.w3.org/TR/rdf-primer>
- [25] D. S. Robertson, J. Agustí, A.C.V. Melo, F. S. Correa da Silva, W.W. Vasconcelos. *Why Ontologies are not Enough for Knowledge Sharing*. In *Joint German/Austrian Conference on Artificial Intelligence (KI' 01)*, Volume 1611 of Lecture Notes in Artificial Intelligence, Springer-Verlag, 1999, pp. 520-529.
- [26] D. Fensel. *Ontologies: Silver Bullet for Knowledge Management and Electronic Commerce*. Springer-Verlag, 2001, pp-1--50.
- [27] M. Fernández. *Overview of Methodologies for Building Ontologies*. In A. Gómez Pérez, N. Guarino, M. Uschold, M. Klein, V.R. Benjamins, B. Chandrasekan, (ed), *Proc. of 16th IJCAI-99 Workshop on Ontologies and Problem Solving Methods*, 1999, Stockholm, Sweden
- [28] D.S. Robertson, V. Brilhante, A.C.V. de Melo, M. Finger, J. Agustí, F.S. Correa da Silva, W.W. Vasconcelos. *On the Insufficiency of Ontologies: Problems in Knowledge Sharing and Alternative Solutions*. *Knowledge-Based Systems*, 15(3) pp. 147--167.
- [29] M.R. Genesereth. *Knowledge Interchange Format*. In J. Allen *et al.*, (ed.), *Proc. of KR-91 Second International Conference on the Principles of Knowledge Representation and Reasoning*. San Francisco: Morgan Kaufman, 1991.
- [30] T. R. Gruber. *Towards Principles for the Design of Ontologies Used for Knowledge Sharing*. In N. Guarino and R. Poli, (eds), *Formal Ontology in Conceptual Analysis and Knowledge Representation*, Deventer The Netherlands, 1993. Kluwer Academic Publishers.

- [31] T. R. Gruber. *A Translation Approach to Portable Ontologies*. Knowledge Acquisition, 5(2), 1993, pp. 199--220
- [32] N. Guarino. *Formal Ontology, Conceptual Analysis and Knowledge Representation*. International Journal of Human and Computer Studies, 43(5/6), 1995, pp. 625--640
- [33] N. Guarino. *Semantic Matching: Formal Ontological Distinctions for Information Organization, Extraction, and Integration*. In M. T. Paziienza, (ed.), *Information Extraction: A Multidisciplinary Approach to an Emerging Information Technology*, Springer-Verlag, 1997, pp. 139--170
- [34] N. Guarino. *Formal Ontology in Information Systems*. In *Proc. of FOIS-98 Trento Italy, 6-8 June 1998*. Amsterdam, IOS Press Amended version of a paper appeared in N. Guarino (ed.), *Formal Ontology in Information Systems*., pp. 3--15, 1998.
- [35] F. van Harmelen, I. Horrocks, P.F. Patel-Schneider. *From SHIQ and RDF to OWL: The Making of a Web Ontology Language*. Journal of Web Semantics, 1(1), 2003.
- [36] P. Patel-Schneider, I. Horrocks. *A Proposal for an OWL Rules Language*. In *Proc. of the 13th International World Wide Web Conference (WWW2004)*. ACM, 2004.
- [37] J. Charlet, P. Zweigenbaum, J. Bouaud, B. Bachimont. *Methodological Principles for Structuring an Ontology*. In *Proc. Workshop on Basic Ontological Issues in Knowledge Sharing, International Joint Conference on Artificial Intelligence IJCAI-95* Montreal Canada, 1995.
- [38] S. DeLoach, J. DiLeo, T. Jacobs. *Integrating Ontologies into Multiagent Systems Engineering*. In *Proc. of 4th International Conference on Agent-Oriented Information Systems AIOS 15-16 July, 2002*, Bologna, Italy, pp. 8--14.
- [39] J. Allen, R. Fikes, P. Hayes, D. McDermott, I. Niles, A. Pease, A. Tate, M. Tyson, Waldinger, J.R. Hobbs, G. Ferguson. *A Daml Ontology of Time*. tech. report, DAML.org, 2002.
- [40] R.B. Altman, M.A. Musen, J.H. Gennari, H. Cheng. *Reuse CORBA and Knowledge-Based Systems*. International Journal of Human-Computer Studies, 49(4), 1998. pp. 523--546,

- [41] A. Lenzi. *Building an Ontology for the Lexicon: Semantic Types and Word Meaning*. In P.N. Skadhauge P. A. Jensen, (ed.), In *Proc. of 1st International OntoQuery Workshop*, University of Southern Denmark, 2001. pp. 103--120
- [42] G. Schreiber, M. Dean. *OWL Web Ontology Language Reference*. tech. report, World Wide Web Consortium (W3C) Recommendation 10 February 2004, <http://www.w3.org/TR/owl-ref/>
- [43] M.S. Fox, M. Grüninger. *The Design and Evaluation of Ontologies for Enterprise Engineering*. In *Workshop on Implemented Ontologies, European Conference on Artificial Intelligence*, Amsterdam NL, 1994.
- [44] P. Charlton, M. Ribiere. *Ontology Overview*. Motorola Labs, Paris. Oktober 2003 <http://www.pa.org/docs/input/f-in-00045/f-in-00045.pdf>
- [45] M. Grüninger, M. Uschold. *Ontologies: Principles, Methods and Applications*. Knowledge Engineering Review, 1996. 1(2), pp. 93--155.
- [46] R. Jasper, M. Uschold. *A Framework for Understanding and Classifying Ontology Applications*. In *Proc. of the IJCAI-99 Workshop on Ontologies and Problem-Solving Methods (KRR5)*, Stockholm, Sweden, 1999.
- [47] D. Mc Guinness. *Ontologies Come of Age*. In *Spinning the Semantic Web*, (eds.) D. Fensel et al. MIT Press Cambridge, 2003, pp.171--197.
- [48] M. Doerr, M. Stif, N. Crofts, I. Dionissiadou. *Definition of the CIDOC Object-Oriented Conceptual Reference Model*. tech. report, ICOM/CIDOC Documentation Standards, September 1999.
- [49] P. Giardetta, N. Guarino. *Ontologies and Knowledge Bases, Towards a Terminological Clarification, Toward Very Large Knowledge Bases*. Knowledge Engineering and Agent Technology, 1995.
- [50] A. Newell. *The Knowledge Level*. Artificial Intelligence, 1982, 18 pp. 87--128
- [51] S.Decker, M.Crubezy, R.W. Ferguson, M.A. Musen, N.F. Noy, M.Sintek. *Creating Semantic Web Contents with Protégé -2000*. IEEE Intelligent Systems, 16(2) 2001, pp. 60--71.

- [52] A. Gómez Pérez. *Knowledge Sharing and Reuse* In *The Handbook on Expert Systems*, CRC Press, 1997.
- [53] R. Poli. *Ontology and Knowledge Organization*. In *Proc. of 4th Conference of the International Society of Knowledge Organization (ISKO 96)*, Washington, 1996.
- [54] K.C. Duarte, A. Candida, C. Natali, R. Falbo, G. Guizzardi. *Software Reuse: Methods Techniques and Tools*. In J. Bosch C. Krueger, (ed.), In *Proc. of the 8th International Conference, ICSR 2004*, Madrid, Spain, July 5-9, Proceedings, Volume 3107 of Lecture Notes in Computer Science, Springer-Verlag 2004, pp. 242--253.
- [55] A. Farquhar, R. Fikes. *Distributed Repositories of Highly Expressive Reusable Ontologies*. *IEEE Intelligent Systems*, 14(2), 1999 pp. 73--79
- [56] D. Fensel, S. Staab, R. Studer, S. Decker. *Situation and Perspective of Knowledge Engineering*. Knowledge Engineering and Agent Technology, 2000
- [57] D.B. Lenat, R. V. Guha. *Cyc: A Midterm Report*. *AI Magazine*, 11(3), 1990, pp. 33--59.
- [58] P.A Reed. *CIDOC Relational Data Model A Guide*. International Documentation Committee of the International Council of Museums (CIDOC).
- [59] C. Goble S. Bechhofer, I. Horrocks, R. Stevens. *Oiled: A Reason-Able Ontology Editor for the Semantic Web*. In G. Brewka, F. Baader, T. Eiter, (eds.), *Joint German/Austrian Conference on Artificial Intelligence (KI' 01)*, Volume 2174 of Lecture Notes in Artificial Intelligence, Springer-Verlag, 2001, pp. 396--408.
- [60] P. Norvig, S. Russel. *Artificial Intelligence: A Modern Approach* Prentice Hall, 1st edition, 1995.
- [61] F. Salvetti. *Cyc*. Technical report, Computer Science Department University of Colorado at Boulder, Boulder Colorado, USA, 2003.
- [62] K. U. Schulz, F. Weigel. *Systematics and Architecture for a Resource Representing Knowledge about Named Entities*. In W.L. Johnson, B. Hayes-Roth, (eds.), *Proc. of the Workshop on Principles and Practice of Semantic Web Reasoning*, Marina del Rey, CA, USA, 2003, pp.189--207 Springer-Verlag, Berlin Heidelberg.

- [63] B. Smith. eds. L. Floridi *Blackwell Guide to the Philosophy of Computing and Information*, pages 155--166. Oxford: Blackwell, 2003.
- [64] J.F. Sowa. *Knowledge Representation: Logical, Philosophical, and Computational Foundations*. PWS Publishing Co., 1998.
- [65] K.P. Sycara. *Multiagent Systems*. AI Magazine, 19(2), 1998, pp.79--92.
- [66] O. Lassila T. Berners-Lee, J. Hendler. *The Semantic Web*. Scientific American, 184(5), 2001, pp. 34--43.
- [67] M. Uschold. *Building Ontologies: Towards A Unified Methodology*. In *Proc. of Expert Systems 96, 16th Annual Conference British Computer Society Specialist, Group on Expert Systems* held in Cambridge, UK on 16-18 1996, 1996.
- [68] M. Uschold. *Where Are The Semantics in the Semantic Web?* AI Magazine, 24(3), 2003, pp. 25--36.
- [69] D. Fensel Y.D. Ding. *Ontology Library Systems: The Key to Successful Ontology Re-Use*. <http://citeseer.ist.psu.edu/455227.html>
- [70] A. Pease, I. Niles. *IEEE Standard Upper Ontology: A Progress Report*. In: Knowledge Engineering Review, 17. Special Issue on Ontologies and Agents, 2002
- [71] A. Gómez Pérez. *Ontological Engineering: A State of The Art* <http://citeseer.ist.psu.edu/444416.html>
- [72] F. Yergeau, T. Bray, J. Paoli, C. M. Sperberg-McQueen, E. Maler *Extensible Markup Language (XML) 1.0* tech. report, World Wide Web Consortium (W3C) 4th February 2004, <http://www.w3.org/TR/2004/REC-xml-20040204/>
- [72] D. Brickley, R. V. Guha. *RDF Vocabulary Description Language 1.0: RDF Schema* World Wide Web Consortium (W3C) tech. report, February 2004, <http://www.w3.org/TR/2004/REC-rdf-schema-20040210>
- [73] S. Luke, L. Spector, D. Rager, J. Hendler. *Ontology-Based Web Agents*. In *Proc. of 1st International Conference on Autonomous Agents (Autonomous Agents 97)*, W. L. Johnson (ed.), New York: Association for Computing Machinery, 1997, pp. 59--66.

- [74] G. A. Miller, R. Beckwith, C. Fellbaum, D. Gross, K. J. Miller. *Introduction to Wordnet: An On-Line Lexical Database*. Journal of Lexicography, 3(4), pp. 234--244, 1990.
- [75] *CNTS Research Center* of the Department of Linguistics of the University of Antwerp Conference on Computational Natural Language Learning (CoNLL-2002) Taipei, Taiwan. August 31 and September 1, 2002
<http://cnts.uia.ac.be/conll2002/ner/>
- [76] W. Pidcock, the Boeing Company. *What Are The Differences Between a Vocabulary, a Taxonomy, a Thesaurus, an Ontology, and a Meta-Model?*
<http://www.metamodel.com/article.php?story=20030115211223271>
- [77] L. M. Garshol. *Ontopia. Metadata? Thesauri? Taxonomies? Topic Maps! Making Sense of It All*. 2004/08/25, <http://www.ontopia.net/topicmaps/materials/tm-vs-thesauri.html>
- [78] H. Alani, *Spatial and Thematic Ontology in Cultural Heritage Information Systems* PhD. Thesis. University of Glamorgan/Prifysgol Morgannwg UK, 2001 May.
- [79] S. Spranger, *Representation of Temporal Knowledge for Web-based Applications*, LMU INSTITUT FUR INFORMATIK Lehr- und Forschungseinheit für Programmier- und Modellierungssprachen, 2002, May, pp. 54--70.
- [80] F. Bry, S. Spranger, *Towards a Multi-Calendar Temporal Type System for (Semantic) Web Query Languages*, 2004 <http://citeseer.ist.psu.edu/638832.html>
- [81] W.Kuhn. *Why Information Science Needs Cognitive Semantics - and What It Has to Offer in Return*. In *Workshop on the Potential of Cognitive Semantics for Ontologies*, November 3rd, 2004, Torino, Italy. Held in conjunction with *FOIS 2004, the International Conference on Formal Ontologies in Information Systems*.
- [82] P. Sorokin *Socio-Cultural Causality, Space, Time*, New York: Russell & Russell 1964.

APPENDIX A

Glossary of Terms

Name	Description
Academic Semester	either of the two usually 18-week periods of instruction into which an academic year is often divided.
Academic Trimester	one of three terms into which the academic year is sometimes divided.
Academic Year	the annual period of sessions of a higher educational institution usually beginning in September and ending in June.
Advent	the period beginning four Sundays before Christmas and observed by some Christians as a season of prayer and fasting.
Advent Sunday	the first Sunday in Advent.
All Saints' Day	Christian holiday November 1 st each year.
Ascension	the Thursday 40 days after Easter observed in commemoration of Christ's ascension to Heaven.
Ash Wednesday	the first day of Lent.
Atatuerk Youth Commemoration Sports Day	Turkish holiday for the youth in commemoration of the beginning of the Independence War of Turkey. May 19 th each year. General suspension of classes.
Calendar Date Periods that are Explicit	periods of time in a given calendar, i.e. calendar days, calendar weeks, months, hours, dates, e.g.12.6.2004, January, 8.00 a.m-12.00 p.m. etc.
Christmas	the time period of app. three days that includes the Christmas Day.
Christmas Day	a Christian feast on December 25 that commemorates the birth of Christ. Implies general suspension of work.
Columbus Day	the second Monday in October observed as a holiday in many states of the U.S. in commemoration of the landing of Columbus in the Bahamas in 1492. General suspension of work.
Day of Unity	German Unification Day, 3 rd October each year.
Duration	how long is one time period e.g. 2 days, 5 hours.
Easter Monday	the Monday after Easter day. Implies general suspension of work.
Easter	a feast that commemorates Christ's resurrection and that is observed with variations of date due to different calendars on the first Sunday after the paschal full moon.
Epiphany	January 6 observed as a church festival in commemoration of the coming of the Magi as the first manifestation of Christ to the Gentiles or in the Eastern Church in commemoration of the baptism of Christ.

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Erntedank Tag	German holiday. The end of the harvest season. <i>Erntedankfest</i> with a special church service is celebrated on the first Sunday of October.
Fall Break	a US American higher education time concept. App. four days off from the classes, during the fall semester of a US American academic year.
Fall Semester	A US American higher education time concept. Last academic semester of the academic year that corresponds to fall. Includes fall break.
Faschingsdienstag	South German-Christian time concept. Corresponds to Carnival (or Fat/Shrove Tuesday or Mardi Gras).
February	the 2 nd month of the Gregorian calendar.
Feast of the Sacrifice	Turkish–Islamic religious holiday. Has a variable date and lasts app. 3 days.
Feast of Sugar	Turkish-Islamic religious holiday that marks the end of Ramadan. Three days long.
Finals Week	a US American higher education time concept. A time period of one week at the end of the last semester of an academic year. The week is reserved for final exams, no classes are held.
Fixed /Variable Calendar Date	it indicates whether a time period can be associated with a given date that never changes or the date associated with it always changes.
General Suspension of Classes or of Work	it is an indicator whether or not in a given time period classes at university or at high-school will be held or businesses will be closed.
German Weekend	Saturday and Sunday of the Gregorian calendar.
Good Friday	the Friday before Easter observed in churches as the anniversary of the crucifixion of Christ. General suspension of work.
Granularity	time unit e.g. hour, month, day, year
Half Term	the period of break between the divisions in a secondary school year.
Halloween	October 31 st observed especially with dressing up in disguise, trick-or-treating and displaying lanterns during the evening.
Hanukkah	an 8-day Jewish holiday beginning on the 25 th of Kislev and commemorating the rededication of the Temple of Jerusalem after its defilement by Antiochus of Syria.
Happy Hour	A period of time during which the price of drinks (as at a bar) is reduced or hors d'oeuvres are served free.
Holiday	any day that is 24 hours long and is associated with a special religious observance, a national celebration, or with a celebration related to a social group, which may indicate a general suspension of work or classes.

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Holy Day	a day set aside for special religious observance.
Holy Week	the week before Easter during which the last days of Christ's life are commemorated.
Iftar	Turkish time concept. Marks the time of sunset during the holy month of Ramadan to indicate that one can start to eat.
Index	it indicates the position of a time period on the timeline e.g. weekend is the 6 th and 7 th days of the week so weekend has the associated index.
Intersession	a period between two academic sessions or terms sometimes utilized for brief concentrated courses.
Israeli Weekend	Friday and Saturday of the Gregorian calendar.
January 12 2004	Simple date entry of Gregorian Calendar.
July 4th	a civil holiday for the celebration of the anniversary of the beginnings of national independence; July 4 th is observed as a national holiday in the U.S. in commemoration of the adoption of the Declaration of Independence in 1776.
Juma	Turkish-Islamic Friday.
Karneval	German time period app. one week long celebrations that include the Carnival Tuesday (also Fat/Shrove Tuesday or Mardi Gras).
Labor Day	US American time concept. Celebrated on the first Monday in September and marks the end of summer holiday and the beginning of fall.
Lent	the 40 weekdays from Ash Wednesday to Easter observed by the Roman Catholic, Eastern, and some Protestant churches as a period of penitence and fasting
Martin's Day	German time period. 11.11 at 11.00 a.m. The first day for the preparation of the approaching Karneval.
Martin Luther King's Birthday	US American holiday. Observed on the Third Monday in January. In commemoration of the assassination of the civil rights fighter Rev. Dr. Martin Luther King
May Day	German time concept. May 1 celebrated in commemoration of the workers' rights on the 1 st of May.
March 30th	simple date entry w.r. t. Gregorian calendar.
Memorial Day	the last Monday in May. General suspension of work.
Mid Terms	a US American higher education time concept. A time period of one week at the end of the first semester of an academic year. The week is reserved for final exams, no classes are held.
Night Shift	Working hours at night, usually starts at 12.00 midnight and continues until 8.00 a.m.

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National Holiday	a holiday, which has a specific meaning for a given nation and which is established by a national legal authority and marked by restrictions on work and on transaction of official business. Implies general suspension of work and general suspension of classes and it has a duration of one day.
National Sovereignty and Children's Day	Turkish holiday for children. 23 rd of April each year. In promotion of the idea that children are the symbol of new Turkey. Implies suspension of classes for students.
Octoberfest	German holiday with 16 days of celebration. No general suspension of work or classes. Begins in September on a Saturday and ends the first Sunday in October.
Palm Sunday	the Sunday before Easter celebrated in commemoration of Christ's triumphal entry into Jerusalem.
Pentecost	a Christian feast on the seventh Sunday after Easter commemorating the descent of the Holy Spirit on the apostles. Called also Whitsunday.
Pessah	a Jewish holiday beginning on the 14 th of Nisan and commemorating the Hebrews' liberation from slavery in Egypt (Passover).
President's Day	US American Holiday. The third Monday in February
Purim	a Jewish holiday celebrated on the 14th of Adar in commemoration of the deliverance of the Jews from the massacre plotted by Haman.
Ramadan	the 9 th month of the Islamic year observed as sacred with fasting practiced daily from dawn to sunset.
Reformation Day	German-Christian holiday in commemoration Martin Luther. 31 st October each year.
Recurrence	it indicates how often a time period repeats. e.g. every year, every day, every six months etc.
Rose Monday	German time concept. Monday before Carnival (or Fat/Shrove Tuesday, Mardi Gras) during the weekly celebrations of Karneval.
Republic Day	Turkish holiday, 29 th of October each year.
Rosh Hashanah	Jewish-Israeli new year acc. to Hebrew calendar. Two days of celebrations.
Rush Hour	a period of the day when the demands especially of traffic or business are at a peak.
School Term	division in a school year during which instruction is regularly given to secondary education students.
Simkat Torah	Jewish Holiday. (The reading of Torah). 1 day long

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Socio-Cultural Time Periods	periods of time that have socio-cultural characteristics i.e. related to a specific religion, a nation or to a social group such a business people or people in higher or secondary education (academia, high schools, etc.), e.g. Semester, Easter, Memorial Day etc.
Socio-Cultural Time Periods that are One Day Long	periods of time that have socio-cultural characteristics and that have a duration of one day. e.g. Thanksgiving Day for USA, Victory Day for Turkey, All Saints' Day for Christianity.
Socio-Cultural Time Periods that are Shorter than One Day	periods of time that have socio-cultural characteristics and that have a duration that is shorter than one day one day.
Socio-Cultural Time Periods that are Longer than One Day	periods of time that have socio-cultural characteristics and that have a duration that is longer than one day one day. e.g. Easter, Academic Semester, Octoberfest.
Spring Break	a US American higher education time concept. App. one week off from the classes, during the spring semester of a US American academic year.
Spring Semester	US American higher education time concept. First academic semester of the academic year that corresponds to spring. Includes Spring Break
Sunday of the Dead	German-Christian holiday (Totensonntag). Observed on the last Sunday in November before Advent.
Thanksgiving Day	US American time concept. The fourth Thursday in November. General suspension of work and classes.
Turkish Weekend	Saturday and Sunday (and at times Friday) of the Gregorian Calendar.
Sabbath	the day of the week observed from Friday evening to Saturday evening as a day of rest and worship by Jews.
School Year	the annual period of sessions of a secondary educational institution.
Semester Break	time off between two semesters.
Semester Hour	a unit of academic credit representing an hour of class (as lecture class) or three hours of laboratory work each week for an academic semester.
Shavuot	a Jewish holiday observed on the 6 th and 7 th of Sivan of the Hebrew calendar in commemoration of the revelation of the Ten Commandments at Mt. Sinai. (Corresponds to Pentecost.)
St.Patrick's Day	Christian holiday celebrated on 17 th March every year.
St. Stephen's Day	second Christmas day (26 th of December).
St.Valentine's Day	Christian holiday on the 14 th of February. No general suspension of work or classes.

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Summer School	a school or school session conducted in summer enabling students to accelerate progress toward a degree, to make up credits lost through absence or failure, or to round out professional education.
Sukkot	a Jewish harvest festival beginning on the 15 th of Tishri and commemorating the temporary shelters used by the Jews during their wandering in the wilderness.
Sylvester	German time concept. Stands for the New Year's Eve. 31 st of December.
Time Periods	all possible periods of time e.g. calendar dates, days of weeks, months, hours, years, holidays, centuries as well as 1700s, 60ies, medieval ages, lunch-time, weekend, etc.
Time Periods Related to Business Life	periods of time that are specific to the group business people.
Time Periods Related to Business Life & Education	periods of time that are specific to the group of business people and academia and secondary education.
Time Periods Related to Higher Education	periods of time that are specific to the group of academia, e.g. Semester, Mid-Terms, etc.
Time Periods Related to Nations	periods of time that are specific to some nation, e.g. Thanksgiving for USA, Oktoberfest for Germany, Republic Day for Turkey.
Time Periods Related to Religions	periods of time that are specific to some religion, e.g. Easter for Christianity, Pessah for Judaism.
Time Periods Related to Secondary Education	periods of time that are specific to the group of secondary education, e.g. School Term.
US American Weekend	Saturday and Sunday of the Gregorian calendar
Vacation	a period of exemption from work for rest and relaxation.
Veterans Day	November 11 set aside in commemoration of the end of hostilities in 1918 and 1945. Observed as a holiday in the U.S. to honor the veterans of the armed forces. General suspension of work.
Victory Day	Turkish holiday. 30 th August each year. In commemoration of the final battle for the independence of Turkey. General suspension of work.
Weekend	the end of the week. The period between the close of one working or business or school week and the beginning of the next.
Whitmonday	Monday after Pentecost
Yom Kippur	a Jewish holiday observed with fasting and prayer on the 10 th day of Tishri in accordance with the rites described in Leviticus 16. (Called also <i>Day of Atonement</i>)
8.00 a.m.	Simple time entry.

APPENDIX B

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Time Periods</i>	Concept of all possible time periods that can be explicitly anchored on the time line	None	No direct instances	<u>subclassOf</u> • (⊔)
<i>Calendar Date Periods</i>		None	<ul style="list-style-type: none"> ▪ February ▪ 8.00 a.m ▪ January_12_2004 ▪ March_30 ▪ 2005 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>TimePeriods</i> <u>superclassOf</u> NONE
<i>Socio-Cultural Time Periods</i>	Concept of time periods related to a specific religion, a nation or to a social group such a business people or people in higher or secondary education	<i>recurrence, has Duration, has Fixed Calendar Date, has Granularity, has Index has Similar Concept, has Subordinate Concept has Superordinate Concept, has Variable Calendar Date, implies General Suspension of Classes, implies General Suspension of Work</i>	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Nations</i> • ...<i>Related to Religions</i> • ...<i>Related to Business Life & Education</i> • ...<i>Duration of One Day</i> • ...<i>Duration of Longer than One Day</i> • ...<i>Duration of Shorter than One Day</i>
<i>Socio-Cultural Time Periods Related to Religions</i>	Concept of time periods related to a specific religion	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Religions with Duration of Longer than One Day</i> • ...<i>Related to Religions withDuration of Shorter thanOne Day</i> • ...<i>Related to Religions with of Longer thanOne Day</i>
<i>Socio-Cultural Time Periods Related to Nations</i>	Concept of time periods related to a specific nation	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-CulturalTimePeriods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...<i>Related to Business Life &Education with Duration of One Day</i> • ...<i>Related to Business Life & Education with Duration of Longer than One Day</i> • ...<i>Related to Business Life & Education with Duration of Shorter One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Business Life & Education</i>	Concept of time periods related to a specific social groups of business people and education	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...Related to Business Life & Education with Duration of One Day • ...Related to Business Life & Education with Duration of Longer than One Day • ...Related to Business Life & Education with Duration of Shorter than One Day
<i>Socio-Cultural Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods having a duration that is longer than one day, e.g. 2 days, one month, 3 weeks or half a year etc.	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Weekend© ▪ Vacation© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural TimePeriods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...Related to Religions with Duration of Longerthan One Day • ...Related to Nations with Duration of Longer than One Day • ...Related to Business Life & Education with of Longer than One Day
<i>Socio-Cultural Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that have a duration of one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Day© ▪ Holiday© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-CulturalTimePeriods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...Related to Religions with Duration of One Day • ...Related to Nations with Duration One Day • ...Related to Business Life & Education with Duration of One Day
<i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that have a duration of one shorter than one day e.g. hours, half a day etc.	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-CulturalTimePeriods</i> <u>superclassOf</u> <ul style="list-style-type: none"> • ...Related to Religions with Duration of Shorter than One Day • ...Related to Nations with Duration of Shorter than One Day • ...Related to Business Life & Education with Duration of Shorter than One Day

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Business Life & Education with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are both related to business life and education and that have a duration, which is longer than a day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life & Education.</i> • <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Business Life & Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Higher Education with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Secondary Education with Duration of Longer than One Day</i>
<i>Socio-Cultural Time Periods Related to Business Life & Education with Duration of One Day</i>	Concept of socio-cultural time periods that are both related to business life and education and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life & Education.</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Business Life & Education</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Higher Education with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Secondary Education with Duration of One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Business Life & Education with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are both related to business life and education and that have a duration, which is shorter than a day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Business Life & Education.</i> <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <i>Socio-Cultural Time Periods Related to Business Life & Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Business Life with Duration of Shorter than One Day</i> <i>Socio-Cultural Time Periods Related to Higher Education with Duration of Shorter than One Day</i> <i>Socio-Cultural Time Periods Related to Secondary Education with Duration of Shorter than One Day</i>
<i>Socio-Cultural Time Periods Related to Nations with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are both related to nations and that have a duration, which is longer than a day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Nations</i> <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <i>Socio-Cultural Time Periods Related Nations</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> <i>Turkish Time Periods with Duration of Longer than One Day</i> <i>Israeli Time Periods with Duration of Longer than One Day</i> <i>US American Time Periods with Duration of One Longer than Day</i> <i>German Time Periods with Duration Longer than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Nations with Duration of One Day</i>	Concept of socio-cultural time periods that are both related nations and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ National Holiday© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Nations</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Turkish Time Periods with Duration of One Day</i> • <i>Israeli Time Periods with Duration of One Day</i> • <i>US American Time Periods with Duration of One Day</i> • <i>German time Periods with Duration One Day</i>
<i>Socio-Cultural Time Periods Related to Nations with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are both related nations and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations</i> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> • <i>Socio-Cultural Time Periods Related to Nations</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Turkish Time Periods with Duration of Shorter than One Day</i> • <i>Israeli Time Periods with Duration of Shorter than One Day</i> • <i>US American Time Periods with Duration of One Shorter than Day</i> • <i>German Time Periods with Duration of Shorter than One Day</i>
<i>Socio-Cultural Time Periods Related to Religions with Duration of Longer One Day</i>	Concept of socio-cultural time periods that are both related religions and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subClassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions</i> • <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Religions</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Jewish Time Periods with Duration of Longer than One Day</i> • <i>Christian Time Periods with Duration of Longer than One Day</i> • <i>Islamic Time Periods with Duration of One Longer than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Religions with Duration of One Day</i>	Concept of socio-cultural time periods that are both related religions and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Holy Day 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Religions</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Jewish Time Periods with Duration of One Day</i> • <i>Christian Time Periods with Duration of One Day</i> • <i>Islamic Time Periods with Duration of One Day</i>
<i>Socio-Cultural Time Periods Related to Religions with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are both related religions and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions</i> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> • <i>Socio-Cultural Time Periods Related to Religions</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Jewish Time Periods with Duration of Shorter than One Day</i> • <i>Christian Time Periods with Duration of Shorter than One Day</i> • <i>Islamic Time Periods with Duration of One Shorter than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Business Life with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to business life and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above		<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life</i> • <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Business Life</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>Socio-Cultural Time Periods Related to Business Life with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to business life and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Business Life</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> NONE
<i>Socio-Cultural Time Periods Related to Business Life with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to business life and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Rush Hour ▪ Happy Hour ▪ Night Shift 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Business Life</i> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> • <i>Socio-Cultural Time Periods Related to Business Life</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Secondary Education with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to secondary education and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Half Term© ▪ School Term ▪ School Year 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> • <i>Socio-Cultural Time Periods with Duration of Longer One Day</i> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>Socio-Cultural Time Periods Related to Secondary Education with Duration One Day</i>	Concept of socio-cultural time periods that are only related to secondary education and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> NONE
<i>Socio-Cultural Time Periods Related to Secondary Education with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to secondary education and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> • <i>Socio-Cultural Time Periods Related to Secondary Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Socio-Cultural Time Periods Related to Higher Education with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to higher education and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Academic Semester ▪ Academic Trimester ▪ Academic Year ▪ Semester Break ▪ Summer School © 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Higher Education</i> • <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> • <i>Socio-Cultural Time Periods Related to Higher Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>US American time Periods of Higher Education with Duration Longer than One Day</i>
<i>Socio-Cultural Time Periods Related to Higher Education with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to higher education and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Higher Education</i> • <i>Socio-Cultural Time Periods with Duration of One Day</i> • <i>Socio-Cultural Time Periods Related to Higher Education</i> \cap <i>Socio-Cultural Time Periods with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> ▪ NONE
<i>Socio-Cultural Time Periods Related to Higher Education with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to higher education and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Semester Hour 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Higher Education</i> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> • <i>Socio-Cultural Time Periods Related to Higher Education</i> \cap <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Israeli Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to Israeli nation and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Israeli Weekend 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Israeli-Jewish Time Periods with Duration of Longer than One Day</i>
<i>Israeli Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to Israeli nation and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Israeli-Jewish Time Periods with Duration of One Day</i>
<i>Israeli Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to Israeli nation and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Israeli-Jewish Time Periods with Duration of Shorter than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Turkish Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to Turkish nation and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Feast of Sugar ▪ Feast of Sacrifice ▪ Ramadan 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Turkish-Islamic Time Periods with Duration of Longer than One Day</i>
<i>Turkish Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to Turkish nation and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Ataturk Youth Commemoration Sports Day ▪ National Sovereignty and Children's' Day ▪ Republic Day ▪ Victory Day 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Turkish-Islamic Time Periods with Duration of One Day</i>
<i>Turkish Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to Turkish nation and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Turkish-Islamic Time Periods with Duration of Shorter than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>US American Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to US American nation and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ US American Weekend 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>US American Time periods of Higher Education with Duration of Longer than One Day</i>
<i>US American Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to US American nation and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Columbus Day ▪ Halloween ▪ July4th ▪ Labor Day© ▪ Martin Luther King's Birthday ▪ Memorial Day ▪ Presidents Day ▪ Thanksgiving Day ▪ Veterans Day 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of One Day</i> <u>superclassOf</u> NONE
<i>US American Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to US American nation and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>German Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to German nation and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ German Weekend ▪ Oktoberfest 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>German-Christian Time Periods with Duration of Longer than One Day</i>
<i>German Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to German nation and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Day of Unity (Tag der Einheit) ▪ Reformation Day ▪ May Day© ▪ Sylvester 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Nations with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>German-Christian Time Periods with Duration of One Day</i>
<i>German Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to German nation and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct Instaces	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Jewish Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to Jewish religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> ▪ <i>Jewish-Israeli Time Periods with Duration of Longer than One Day</i>
<i>Jewish Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to Jewish religion and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Jewish-Israeli Time Periods with Duration of One Day</i>
<i>Jewish Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to Jewish religion and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>Jewish-Israeli Time Periods with Duration of Shorter than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Islamic Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to Islamic religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Religions with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> <i>Turkish-Islamic Time Periods with Duration of Longer than One Day</i>
<i>Islamic Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to Islamic religion and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Religions with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> <i>Turkish-Islamic Time Periods Related to Religions with Duration of One Day</i>
<i>Islamic Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to Islamic religion and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	No direct instances	<u>subclassOf</u> <ul style="list-style-type: none"> <i>Socio-Cultural Time Periods Related to Religions with Duration of Shorter than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> <i>Turkish-Islamic Time Periods Related to Religions with Duration of Shorter than One Day</i>

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Christian Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are only related to Christian religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Advent © ▪ Christmas © ▪ Easter © ▪ Holy Week ▪ Lent 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of Longer than One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>German Christian Time Periods with Duration of Longer than One Day</i>
<i>Christian Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are only related to Christian religion and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Advent Sunday © ▪ All Saints' Day ▪ Ascension ▪ Ash Wednesday ▪ Christmas Day © ▪ Easter Monday© ▪ Epiphany ▪ Good Friday ▪ Palm Sunday ▪ St. Patrick's Day ▪ St. Stephens Day ▪ St. Valentine's Day ▪ Whitmonday ▪ Pentecost 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of One Day</i> <u>superclassOf</u> <ul style="list-style-type: none"> • <i>German-Christian Time Periods with Duration of One Day</i>
<i>Christian Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are only related to Christian religion and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Socio-Cultural Time Periods Related to Religions with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>German-Christian Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are both related to German nation and Christian Religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Karneval© 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>German Time Periods with Duration of Longer than One Day</i> • <i>Christian Time Periods with Duration of Longer than One Day</i> • <i>German Time Periods with Duration of Longer than One Day</i> \cap <i>Christian Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>Israeli-Jewish Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are both related to Israeli nation and Jewish religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Hanukkah ▪ Pessah ▪ Ros Hashanah ▪ Sukkot 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Israeli Time Periods with Duration of Longer than One Day</i> • <i>Jewish Time Periods with Duration of Longer than One Day</i> • <i>Israeli Time Periods with Duration of Longer than One Day</i> \cap <i>Jewish Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>Turkish-Islamic Time Periods with Duration of Longer than One Day</i>	Concept of socio-cultural time periods that are both related to Turkish nation and Islamic religion and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Juma 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Turkish Time Periods with Duration of Longer than One Day</i> • <i>Islamic Time Periods with Duration of Longer than One Day</i> • <i>Turkish Time Periods with Duration of Longer than One Day</i> \cap <i>Islamic Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>US American Periods of Higher Education with Duration Longer than One Day</i>	Concept of socio-cultural time periods that are both related to US American nation and higher Education and that have a duration, which is longer than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Fall Break ▪ Fall Semester ▪ Finals Week ▪ Intersession ▪ Mid Terms ▪ Spring Break ▪ Spring Semester 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>US American Time Periods with Duration of Longer than One Day</i> • <i>Higher Education Time Periods with Duration of Longer than One Day</i> • <i>US American Time Periods with Duration of Longer than One Day</i> \cap <i>Higher Education Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>German-Christian Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are both related to German nation and Christian Religion and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Ernte Dank Tag ▪ Faschings Dienstag ▪ Martin's Day ▪ Rose Monday ▪ Sunday of the Dead 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>German Time Periods with Duration of One Day</i> • <i>Christian Time Periods with Duration of One Day</i> • <i>German Time Periods with Duration of One Day</i> \cap <i>Christian Time Periods with Duration of One Day</i> <u>superclassOf</u> NONE

Concept Dictionary

Category Name	Category Description	Category Properties (attributes)	Category Instances (instanceOf)	Category Relations (subclassOf-superclassOf)
<i>Israeli-Jewish Time Periods with Duration of One Day</i>	Concept of socio-cultural time periods that are both related to Israeli nation and Jewish Religion and that have a duration, which is one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Purim ▪ Sabbath© ▪ Shavuot ▪ Simkat Torah ▪ Yom Kippur 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Israeli Time Periods with Duration of One Day</i> • <i>Jewish Time Periods with Duration of One Day</i> • <i>Israeli Time Periods with Duration of One Day</i> \cap <i>Jewish Time Periods with Duration of One Day</i> <u>superclassOf</u> NONE
<i>Israeli-Jewish Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are both related to Israeli nation and Jewish Religion and that have a duration, which is shorter than one day	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	NONE	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Israeli Time Periods with Duration of Shorter than One Day</i> • <i>Jewish Time Periods with Duration of Shorter than One Day</i> • <i>Israeli Time Periods with Duration of Shorter than One Day</i> \cap <i>Jewish Time Periods with Duration of Longer than One Day</i> <u>superclassOf</u> NONE
<i>Turkish-Islamic Time Periods with Duration of Shorter than One Day</i>	Concept of socio-cultural time periods that are both related to Turkish nation and Islamic Religion and that have a duration, which is shorter than one	inherits from <i>Socio-Cultural Time Periods</i> , therefore same as above	<ul style="list-style-type: none"> ▪ Iftar 	<u>subclassOf</u> <ul style="list-style-type: none"> • <i>Turkish Time Periods with Duration of Shorter than One Day</i> • <i>Islamic Time Periods with Duration of Shorter than One Day</i> • <i>Turkish Time Periods with Duration of Shorter than One Day</i> \cap <i>Islamic Time Periods with Duration of Shorter than One Day</i> <u>superclassOf</u> NONE

APPENDIX C

Specially Treated Socio-Cultural Time Concepts

Advent© and Advent Sunday©: Advent is the time period at begins four Sundays before Christmas and observed by some Christians as a season of prayer and fasting. In the Ontology of Socio-Cultural Time *Concepts* Advent© is modelled as a Christian time period that is longer than one day. As such the time period includes all four Sundays i.e. all four Advent Sundays. However, in the natural language, the expression “Advent” can be used to mean the time period of one Advent Sunday, thus it may denote a time period that is one day. The Ontology of Socio-Cultural Time *Expressions* shows both uses, whereas in the Ontology of Socio-Cultural Time *Concepts* Advent © is a time period that is longer than one day and Advent Sunday © is a time period that is one day.

Christmas© and Christmas Day©: In the Ontology of Socio-Cultural Time *Concepts* Christmas© is defined as a time period that is longer than one day. This refers to the time period that starts on the 25th of December and lasts three days including 26th and 27th of December. Christmas Day © on the other hand, is associated with the actual Christmas Day on the 25th of December and denotes a time period that is one day long. In the natural language the use of expression “Christmas” is ambiguous; it may refer to the time period of three days or occasionally even to a longer time period but it may also refer to the actual Christmas Day on the 25th of December.

Easter© and Easter Monday©: In the Ontology of Socio-Cultural Time *Concepts* Easter© is defined as a time period that is longer than one day. This refers to the time period that includes the Easter day and the subsequent Easter Monday. Easter Monday© on the other hand, refers to time period that is one day long. In the natural language the use of expression “Easter” is ambiguous; it may refer to the time period of that consists of Easter Day and Easter Monday or it may refer to the actual Easter day.

Half Term©: The time period off between the divisions in a school year. The way it is used in the natural language, “Half Term” may also denote the time period off between the divisions of two academic semesters , thus it can be related to higher education. However, in the Ontology of Socio-Cultural Time *Concepts*, it is modelled as only in relation to secondary education.

Holiday©: In the Ontology of Socio-Cultural Time *Concepts*, the time concept of Holiday© is modelled as a time period that is one day and that is associated with a special religious observance, or a national celebration, or a celebration related to a social group, which in some cases indicates a general suspension of work or classes. In the natural language, the expression “Holiday” has various denotations. It may refer to a time period of one day (e.g. Thanksgiving) but it may also refer to a time period of longer than one day (e.g. summer holiday). Moreover, the time period holiday may be determined by a legal authority (e.g. Republic Day) but it may also be determined by the individual (vacation).

Karneval© and Carnival©: Ontology of Socio-Cultural Time *Concepts* distinguishes between the concept of Karneval©, and the concept of Carnival©. We model Karneval© as a German-Christian time concept, which denotes a week of festivities. The week includes the days Karneval Donnerstag (which is the preceding Thursday), Rosenmontag (Rose Monday), Fastnachtsdienstag (Fat Tuesday/Shrove Tuesday/Mardi Gras/Carnival) and Fastnachtmittwoch (Ash Wednesday). Hence, “Karneval” denotes a time period that is longer than one day. Time Concept Carnival© on the other hand, is modelled as a socio-cultural time concept related to Christian religion that denotes a time period of one day. As such Carnival© is an equivalent concept

of Mardi Gras, Fat Tuesday or Shrove Tuesday. In the natural language, however, the expression ‘Carnival’ and the expression ‘Karneval’ are often used interchangeably and the distinction between the two is frequently not recognized.

May Day© and Labor Day©: May Day is celebrated on the 1st of May in commemoration of the workers’ rights in most Europe and most other countries. Accordingly, in Germany May Day is celebrated in this sense and is also referred as Labor Day. In the USA, on the other hand, May Day is celebrated on the 1st of May to welcome the arrival of spring without having any connotation to the workers’ rights. Time concept of Labor Day in the US American culture is independent of the time concept of May Day and it is celebrated on the first Monday in September. It marks the end of summer holiday and the beginning of fall. In the Ontology of Socio-Cultural Time *Concepts* May Day is classified under the category *German Time Periods with Duration One Day*. Labor Day is classified under the category *US American Time Periods with Duration of One Day*. In natural language, the two expressions are used interchangeably.

National Holiday©: We interpret National Holiday© as a holiday, which has a specific historical meaning for a given nation and which is established by a national legal authority and marked by restrictions on work and on transaction of official business. So, National Holiday© implies general suspension of work and general suspension of classes and it has a duration of one day. For example, July 4th for USA, which is their independence day, and Unification Day for Germany, which symbolizes the unification of eastern and western Germany. Hence, in our model, National Holiday© is an instance of the category of *Socio-Cultural Time Periods Related to Nations with Duration of One Day*. In the natural language, the expression ‘National Holiday’ might refer to the time period, which is reserved to the special celebrations of one nation. For example, Carnival period may be referred to as the national holiday of Brazil, thus it may correspond to a time period that is longer than one day.

Sabbath©: In our model Sabbath© is considered as an Israeli-Jewish time period that has a duration of one day. In natural language, the expression ‘Sabbath’ can be used to imply a day taken for free activities or a certain period of time, when one engages in work activities other than the regular work.

Summer School©: A school session conducted in summer enabling students to accelerate progress toward a degree, to make up credits lost through absence or failure, or to round out professional education. In the Ontology of Socio-Cultural Time *Concepts*, Summer School© is associated to higher education and it has duration of three weeks. In the natural language, the expression ‘Summer School’ may be used also to refer to the time period related to secondary education institutions, language courses or other educational institutions with varying duration.

Weekend©: In the Ontology of Socio-Cultural Time *Concepts*, we consider the concept of Weekend as a period of time that has socio-cultural characteristics. The reason for our regard is that the concept of weekend may depend on a socio-cultural group. As mentioned, Weekend© in most western cultures refers to the weekdays of Saturday and Sunday, whereas in most Middle Eastern cultures the concept of Weekend© refers to the days of Friday and Saturday. Similarly, the museum workers mostly need to work on Sundays and have their Weekend on Mondays. Other time formalisms may consider it as a regular time concept that marks the end of a regular time period of week. Moreover, we distinguish between Turkish, Israeli, German and US American Weekends in order to emphasize the distinct time conceptions. In Germany, USA and Turkey Weekend© includes Saturday and Sunday, whereas in Israel Weekend© is Friday and Saturday w.r.t. Gregorian calendar. In the Ontology of Socio-Cultural Time *Concepts*, Weekend© is modelled as a time period that is longer than one day and that denotes general suspension of classes or work. In the natural

language, however, the expression “Weekend”, depending on the social group, may refer to time period that is one day long only including Sunday or Monday etc.

Vacation©: In the Ontology of Socio-Cultural Time *Concepts* Vacation© is modelled as a period of time off from work, which is reserved for relaxation. The time period is determined by the individual, thus it is independent of the determination of a public authority and it has duration that is necessarily longer than one day. In natural language, the expression “Vacation” are used interchangeably with the expression “Holiday”.

APPENDIX D

Instances Table

Instance: July 4th

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

National Holiday
 Independence Day
 Day
 TRUE
 FALSE
 Yearly
 TRUE
 one day
 TRUE
 4th of July

Instance: 8.00 a.m.

Associated Category: *Calendar date Periods*

Properties

NONE

PropertyValues

NONE

Instance: Academic Semester

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

Academic Year
 Fall Semester, Spring Semester
 Academic Term, Academic Session
 week
 FALSE
 TRUE
 yearly
 FALSE
 18 weeks
 FALSE

Instance: Academic Trimester

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work

PropertyValues

Academic Year
 Fall Semester, Spring Semester, Summer Semester
 Academic Term, Academic Session
 week
 FALSE
 TRUE
 yearly
 FALSE

:

has Duration: 18 weeks
implies General Suspension of Classes: FALSE
has Index:

Instance: Academic Year

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 Academic Semester, Academic Trimester
 NONE
 month
 FALSE
 TRUE
 yearly
 FALSE
 8 months
 FALSE

Instance: Advent

Associated Category: *Christian Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 Advent Sunday
 NONE
 day
 FALSE
 TRUE
 yearly
 FALSE
 4 Sundays
 FALSE
 Starts 4 Sundays before Christmas

Instance: Advent Sunday

Associated Category: *Christian Time Periods with Duration One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Advent, Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 FALSE
 1 day
 FALSE
 First Advent Sunday is 4 Sundays before Christmas

Instance: All Saints' Day

Associated Category: *Christian Time Periods with Duration One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 1 day
 TRUE
 1st November

Instance: Atatuerk Youth Commemoration and Sports Day

Associated Category: *Turkish Time Periods with Duration One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 FALSE
 1 day
 TRUE
 19th of May

Instance: Christmas

Associated Category: *Christian Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

NONE
 Christmas Day, St. Stephen's Day
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 3 days
 TRUE
 Starts on 25th December

Instance: Christmas Day

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:

PropertyValues

Christmas, Holiday
 NONE
 NONE
 day

<i>has Fixed Calendar Date:</i>	TRUE
<i>has Variable Calendar Date:</i>	FALSE
<i>recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	TRUE
<i>has Duration:</i>	1 day
<i>implies General Suspension of Classes:</i>	TRUE
<i>has Index:</i>	25 th December

Instance: Columbus Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Holiday
 NONE
 Discovery of the American Continent
 day
 FALSE
 TRUE
 yearly
 TRUE
 1 day
 TRUE
 2nd Monday in October

Instance: Day of Unity

Associated Category: *German Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

National Holiday
 NONE
 Unification of Germany, Tag der Einheit
 day
 TRUE
 FALSE
 yearly
 TRUE
 1 day
 TRUE
 3rd of October

Instance: Easter

Associated Category: *Christian Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 Easter Monday, Good Friday
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 4 days
 TRUE
 After 40 days of Lent

Instance: Easter Monday

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
 has Granularity:
 has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Easter, Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 1 day
 TRUE
 Monday after Good Friday

Instance: Epiphany

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 1 day
 TRUE
 6th January

Instance: Erntedank Tag

Associated Category: *German-Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Holiday
 NONE
 thanksgiving Day
 day
 FALSE
 TRUE
 yearly
 TRUE
 1 day
 TRUE
 1st Sunday in October

Instance: Fall Break

Associated Category: *US American Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:

Property Values

NONE
 NONE
 NONE
 day

<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>has Duration:</i>	3 days
<i>implies General Suspension of Classes:</i>	TRUE
<i>has Index:</i>	in October

Instance: Fall Semester

Associated Category: *US American Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:

Property Values

Academic Semester
NONE

has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

NONE
week
FALSE
TRUE
yearly
FALSE
18 weeks
FALSE
late August

Instance: Faschingsdienstag

Associated Category: *German-Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Karneval
NONE
Mardi Gras, Carnival, Fat Tuesday, Shrove Tuesday
day
FALSE
TRUE
yearly
TRUE
1days
TRUE
Tuesday during the Karneval week, 1 day before Ash
Wednesday

Instance: Feast of Sugar

Associated Category: *Turkish-Islamic Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:

Property Values

NONE
NONE
Festival of fast breaking
day
FALSE
TRUE
yearly
TRUE
3 days
TRUE

has Index: at the end of Ramadan

Instance: Feast of the Sacrifice

Associated Category: *Turkish-Islamic Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 NONE
 NONE
 3 days
 FALSE
 TRUE
 yearly
 TRUE
 3 days
 TRUE
 10th day of the 12th last month of the Islamic calendar

Instance: February

Associated Category: *Calendar Date Periods*

Properties

NONE:

Property Values

NONE

Instance: Finals Week

Associated Category: *US American Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Spring Semester
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE
 1 week
 TRUE
 Last week of the spring semester of the academic year

Instance: German Weekend

Associated Category: *German Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 NONE
 NONE
 day
 FALSE
 TRUE
 weekly
 FALSE
 2 days
 TRUE
 6th and 7th days of the week (Saturday and Sunday)

Instance: Good Friday

Associated Category: *Christian Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Easter, Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 1 day
 TRUE
 Friday before Easter Monday

Instance: Half Term

Associated Category: *Socio-Cultural Time Periods of Secondary Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 NONE
 Half Term Vacation
 week
 FALSE
 TRUE
 yearly
 FALSE
 2 weeks
 TRUE
 between two high school terms

Instance: Halloween

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 FALSE
 2 weeks
 FALSE
 31st October

Instance: Hanukkah

Associated Category: *Israeli-Jewish Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:

Property Values

NONE
 NONE
 Festival of Lights

<i>has Granularity:</i>	day
<i>has Fixed Calendar Date:</i>	TRUE
<i>has Variable Calendar Date:</i>	FALSE
<i>recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>has Duration:</i>	8 days
<i>implies General Suspension of Classes:</i>	FALSE
<i>has Index:</i>	begins 25 th of Jewish month Kislev (corresponds to November and December)

Instance: Happy Hour

Associated Category: *Socio-Cultural Time Periods of Business Life with Duration of Shorter than One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

PropertyValues

NONE
NONE
NONE
hour
TRUE
FALSE
daily
TRUE
FALSE
3 hours
17.00-20.00 and 23.00-01.00

Instance: Holiday

Associated Category: *Socio-Cultural Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>

PropertyValues

NONE
Simkat Torah , Advent Sunday, Sunday of the Dead, Yom Kippur, Easter Monday, Victory Day, Veterans' Day, Ash Wednesday, Hanukkah, President' s Day, Shavuot, Rose Monday, Ascencion, Palm Sunday, Erntedank Tag, Atatuerk Youth Commemoration Sports Day, Columbus Day, StValentine' s Day, Faschingsdienstag, Labor Day. May Day, Christmas Day, Sylvester, All Saints' Day, National Sovereignty and Childrens' Day, Whitmonday, Thanksgiving Day, Reformation Day, Martin' sDay, Epiphany, Memorial Day, St.Patrick' s Day, Pentecost, Halloween, Martin Luther King' s Birthday
NONE
NONE
day
1 day

Instance: Holy Day

Associated Category: *Socio-Cultural Time Periods of Religions with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

NONE
 Sabbath, Sunday, Juma
 NONE
 day
 FALSE
 TRUE
 weekly
 TRUE
 TRUE
 1 day
 5th, 6th or 7th day of the week

Instance: Holy Week

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

NONE
 NONE
 Passion Week
 week
 FALSE
 TRUE
 weekly
 FALSE
 FALSE
 FALSE
 1 week
 last week before Easter Monday

Instance: Iftar

Associated Category: *Turkish-Islamic Time Periods with Duration of Shorter than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

NONE
 NONE
 NONE
 hour
 FALSE
 TRUE
 daily
 TRUE
 TRUE
 1 month during Ramadan
 After sunset

Instance: Intersession

Associated Category: *US American Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:

PropertyValues

NONE
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE

<i>implies General Suspension of Classes</i>	TRUE
<i>has Duration:</i>	3 weeks
<i>has Index</i>	between two academic semesters

Instance: Israeli-Weekend

Associated Category: *Israeli Time Periods of Higher Education with Duration of Longer than One Day*

<u>Properties</u>	<u>Property Values</u>
<i>has Superordinate Concept:</i>	NONE
<i>has Subordinate Concept:</i>	NONE
<i>has Similar Concept:</i>	NONE
<i>has Granularity:</i>	day
<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>Recurrence:</i>	weekly
<i>implies General Suspension of Work:</i>	TRUE
<i>implies General Suspension of Classes</i>	TRUE
<i>has Duration:</i>	2 days
<i>has Index</i>	5 th and 6 th days of the week (Friday, Saturday)

Instance: 12.January.2004

Associated Category: *Calendar Date Periods*

<u>Properties</u>	<u>Property Values</u>
NONE:	NONE

Instance: Juma

Associated Category: *Turkish-Islamic Time Periods with Duration of One Day*

<u>Properties</u>	<u>Property Values</u>
<i>has Superordinate Concept:</i>	Holy Day
<i>has Subordinate Concept:</i>	NONE
<i>has Similar Concept:</i>	Day of Rest, Religious Day, Friday
<i>has Granularity:</i>	Day
<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>recurrence:</i>	weekly
<i>implies General Suspension of Work:</i>	TRUE
<i>implies General Suspension of Classes</i>	FALSE
<i>has Duration:</i>	1 day
<i>has Index</i>	5 th day of the week (Friday)

Instance: Karneval

Associated Category: *German-Christian Time Periods with Duration of Longer than One Day*

<u>Properties</u>	<u>Property Values</u>
<i>has Superordinate Concept:</i>	NONE
<i>has Subordinate Concept:</i>	Faschingsdienstag(Fat/Shrove Tuesday/Carnival)
<i>has Similar Concept:</i>	NONE
<i>has Granularity:</i>	day
<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>Recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>implies General Suspension of Classes</i>	FALSE
<i>has Duration:</i>	6 days
<i>has Index</i>	starts 6 days before Ash Wednesday

Instance: Labor Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 1 day
 1st Monday in September

Instance: Lent

Associated Category: *Christian Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 40 days
 begins with Ash Wednesday 40 days before Easter

Instance: March 30

Associated Category: *Calendar Date Periods*

Properties

NONE:

Property Values

NONE

Instance: Martin Luther King's Birthday

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 1 day
 3rd Monday in January

Instance: Martin's Day

Associated Category: *German-Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 FALSE
 FALSE
 1 day
 11.11. at 11.00 a.m.

Instance: May Day

Associated Category: *German Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 Workers' Day
 day
 TRUE
 FALSE
 yearly
 FALSE
 FALSE
 1 day
 1st of May

Instance: Memorial Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 1 day
 last Monday in May

Instance: Mid-Terms

Associated Category: *US American Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:

PropertyValues

Fall Semester
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE
 TRUE

has Duration: 1 week
has Index last week of the first semester of an academic year

Instance: National Holiday

Associated Category: *Socio-Cultural Time Periods Related to Nations with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 Republic Day, July 4th, Day of Unity
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 TRUE
 1 day

Instance: National Sovereignty and Children's Day

Associated Category: *Turkish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 FALSE
 TRUE
 1 day
 23rd of April

Instance: Night Shift

Associated Category: *Socio-Cultural Time Periods of Business Life with Duration of Shorter than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 NONE
 NONE
 hour
 TRUE
 FALSE
 daily
 FALSE
 FALSE
 8 hours
 starts at 12.00 midnight

Instance: Oktoberfest

Associated Category: *German Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:

Property Values

NONE
 NONE
 Wiesn

<i>has Granularity:</i>	day
<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>Recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>implies General Suspension of Classes:</i>	FALSE
<i>has Duration:</i>	16 days
<i>has Index:</i>	starts on 3 rd Saturday in September

Instance: Palm Sunday

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

Holiday
NONE
NONE
day
FALSE
TRUE
yearly
TRUE
TRUE
1 day
last Sunday before Easter

Instance: Pentecost

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

Holiday
NONE
Whitsunday, Shavuot
day
FALSE
TRUE
yearly
TRUE
TRUE
1 day
50 days after Easter

Instance: Pessah

Associated Category: *Israeli-Jewish Time Periods with Duration of Longer than One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

NONE
NONE
Passover
day
FALSE
TRUE
yearly
TRUE
TRUE
app. a week
app. in April

Instance: President's Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 1 day
 3rd Monday in February

Instance: Purim

Associated Category: *Israeli-Jewish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 Fasching
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 1 day
 app. in March

Instance: Ramadan

Associated Category: *Turkish-Islamic Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 NONE
 NONE
 month
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 1 month
 9th month acc. to the Islamic calendar

Instance: Reformation Day

Associated Category: *German Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:

Property Values

Holiday
 NONE
 NONE
 day
 TRUE

<i>has Variable Calendar Date:</i>	FALSE
<i>Recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>implies General Suspension of Classes:</i>	FALSE
<i>has Duration:</i>	1 day
<i>has Index:</i>	31 st of October

Instance: Republic Day

Associated Category: *Turkish Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

National Holiday
NONE
NONE
day
TRUE
FALSE
yearly
TRUE
TRUE
1 day
29 th of October

Instance: Ros Hashanah

Associated Category: *Israeli-Jewish Time Periods with Duration of Longer than One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

NONE
NONE
Israeli-Jewish New Year
day
FALSE
TRUE
yearly
TRUE
TRUE
2 days

Instance: Rose Monday

Associated Category: *German-Christian Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

Holiday
NONE
NONE
day
FALSE
TRUE
yearly
FALSE
FALSE
1 day
Monday before Carnival (or Fat Tuesday, Mardi Gras)

Instance: Rush Hour

Associated Category: *Socio-Cultural Time Periods of Business Life with Duration of Shorter than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 NONE
 NONE
 hour
 FALSE
 TRUE
 daily
 FALSE
 FALSE
 2 hours
 1st to 5th days of the week between 8.00-10.00 and
 18.00-20.00 p.m.

Instance: Sabbath

Associated Category: *Israeli-Jewish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holy Day
 NONE
 Religious Day, Saturday, Day of Rest
 day
 FALSE
 TRUE
 weekly
 TRUE
 TRUE
 1 day
 6th day of the week.

Instance: School Term

Associated Category: *Socio-Cultural Time Periods of Secondary Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

School Year
 NONE
 School Semester
 month
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 5 months
 starts in September

Instance: School Year

Associated Category: *Socio-Cultural Time Periods of Secondary Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:

Property Values

NONE
 NONE
 NONE
 month

<i>has Fixed Calendar Date:</i>	FALSE
<i>has Variable Calendar Date:</i>	TRUE
<i>Recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>implies General Suspension of Classes:</i>	FALSE
<i>has Duration:</i>	10 months
<i>has Index:</i>	starts in September

Instance: Semester Break

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

NONE
 NONE
 Term Break
 week
 FALSE
 TRUE
 yearly
 FALSE
 TRUE
 8 weeks
 between two academic semesters

Instance: Semester Hour

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Shorter than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Academic Semester
 NONE
 Credit Hour
 hour
 FALSE
 FALSE
 1 class hour or 3 lab hours

Instance: Shavuot

Associated Category: *Israeli-Jewish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 Pentecost, Whitsunday
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 TRUE
 1 day
 50 days after Pesach

Instance: Simkat Torah

Associated Category: *Israeli-Jewish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 Reading of Torah
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 1 day

Instance: Spring Break

Associated Category: *US American Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

NONE
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE
 TRUE
 1 week
 in March

Instance: Spring Semester

Associated Category: *US American Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Acedemic Semester
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE
 FALSE
 18 weeks

Instance: St. Patrick's Day

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:

Property Values

Christmas, Holiday
 NONE
 NONE
 day
 TRUE

<i>has Variable Calendar Date:</i>	FALSE
<i>Recurrence:</i>	yearly
<i>implies General Suspension of Work:</i>	FALSE
<i>implies General Suspension of Classes:</i>	FALSE
<i>has Duration:</i>	1 day
<i>has Index:</i>	17 th of March

Instance: St. Stephen's Day

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

Christmas, Holiday
NONE
Boxing Day, Second Christmas Day
day
TRUE
FALSE
yearly
TRUE
TRUE
1 day
26 th of December

Instance: St. Valentine's Day

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

Holiday
NONE
NONE
day
TRUE
FALSE
yearly
FALSE
FALSE
1 day
14 th of February

Instance: Sukkot

Associated Category: *Israeli-Jewish Time Periods with Duration of Longer than One Day*

Properties

<i>has Superordinate Concept:</i>
<i>has Subordinate Concept:</i>
<i>has Similar Concept:</i>
<i>has Granularity:</i>
<i>has Fixed Calendar Date:</i>
<i>has Variable Calendar Date:</i>
<i>Recurrence:</i>
<i>implies General Suspension of Work:</i>
<i>implies General Suspension of Classes:</i>
<i>has Duration:</i>
<i>has Index:</i>

Property Values

NONE
NONE
NONE
day
FALSE
TRUE
yearly
TRUE
TRUE
2 days
late September, October

Instance: Summer School

Associated Category: *Socio-Cultural Time Periods of Higher Education with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

NONE
 NONE
 NONE
 week
 FALSE
 TRUE
 yearly
 FALSE
 TRUE
 3 weeks
 in summer

Instance: Sunday

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holy Day
 NONE
 Religious Day, Rest Day
 day
 FALSE
 TRUE
 weekly
 TRUE
 TRUE
 1 day
 7th day the of week

Instance: Sunday of the Dead

Associated Category: *German-Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 NONE
 day
 FALSE
 TRUE
 yearly
 TRUE
 FALSE
 1 day
 last Sunday before Advent

Instance: Sylvester

Associated Category: *German Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:

PropertyValues

Holiday
 NONE
 New Year's Eve
 day
 TRUE
 FALSE
 yearly
 FALSE

<i>implies General Suspension of Classes</i>	FALSE
<i>has Duration:</i>	1 day
<i>has Index</i>	31 st of December

Instance: Thanksgiving Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

Property Values

Holiday
 NONE
 Erntedank Tag
 day
 FALSE
 TRUE
 yearly
 TRUE
 TRUE
 1 day
 4th Thursday in November

Instance: Turkish Weekend

Associated Category: *Turkish Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 NONE
 NONE
 day
 FALSE
 TRUE
 weekly
 FALSE
 2 days
 TRUE
 6th and 7th days of the week (Saturday and Sunday)

Instance: US American Weekend

Associated Category: *German Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

Property Values

NONE
 NONE
 NONE
 day
 FALSE
 TRUE
 weekly
 FALSE
 2 days
 TRUE
 6th and 7th days of the week (Saturday and Sunday)

Instance: Vacation

Associated Category: *Socio-Cultural Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
recurrence:
implies General Suspension of Work:
has Duration:
implies General Suspension of Classes:
has Index:

PropertyValues

NONE
 NONE
 NONE
 day, week
 FALSE
 TRUE
 yearly
 FALSE
 longer than 1 day
 FALSE

Instance: Veteran's Day

Associated Category: *US American Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 TRUE
 TRUE
 1 day
 11th of November

Instance: Victory Day

Associated Category: *Turkish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:
implies General Suspension of Classes:
has Duration:
has Index

PropertyValues

Holiday
 NONE
 NONE
 day
 TRUE
 FALSE
 yearly
 TRUE
 TRUE
 1 day
 30th of August

Instance: Weekend

Associated Category: *Socio-Cultural Time Periods with Duration of Longer than One Day*

Properties

has Superordinate Concept:
has Subordinate Concept:
has Similar Concept:
has Granularity:
has Fixed Calendar Date:
has Variable Calendar Date:
Recurrence:
implies General Suspension of Work:

PropertyValues

NONE
 NONE
 NONE
 day
 FALSE
 TRUE
 weekly

implies General Suspension of Classes

has Duration:

2 days

has Index

6th and 7th days of the week

Instance: Whitmonday

Associated Category: *Christian Time Periods with Duration of One Day*

Properties

has Superordinate Concept:

has Subordinate Concept:

has Similar Concept:

has Granularity:

has Fixed Calendar Date:

has Variable Calendar Date:

Recurrence:

implies General Suspension of Work:

implies General Suspension of Classes

has Duration:

has Index

Property Values

Holiday

NONE

NONE

day

FALSE

FALSE

yearly

TRUE

TRUE

1 day

1 day after Whitsunday

Instance: Yom Kippur

Associated Category: *Israeli-Jewish Time Periods with Duration of One Day*

Properties

has Superordinate Concept:

has Subordinate Concept:

has Similar Concept:

has Granularity:

has Fixed Calendar Date:

has Variable Calendar Date:

Recurrence:

implies General Suspension of Work:

implies General Suspension of Classes

has Duration:

has Index

Property Values

Holiday

NONE

Jewish Day of Atonement

day

FALSE

TRUE

yearly

TRUE

TRUE

1 day

late September early October

Appendix E

OWL Source Code of the Ontology of Socio-Cultural Time Concepts

```
<rdf:RDF xmlns:rss="http://purl.org/rss/1.0/"
xmlns:jms="http://jena.hpl.hp.com/2003/08/jms#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:vcard="http://www.w3.org/2001/vcard-rdf/3.0#"
xmlns:daml="http://www.daml.org/2001/03/daml+oil#"
xmlns:dc="http://purl.org/dc/elements/1.1/"
xmlns="http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl#"
xml:base="http://www.cip.ifi.lmu.de/~oezden/STCONCEPTS.owl">
```

```
<owl:Ontology rdf:about=""/>
```

```
<!-------CLASSES----->
```

```
<!--Class Time Periods -->
```

```
<owl:Class rdf:ID="TimePeriods">
```

```
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of all possible
temporal periods that can be explicitly anchored on the time line and that a have a duration and that repeat.
e.g calendar dates, days of weeks, months, hours of days, years, holidays, centuries as well as midnight,
yesterday, next year, 1700s, 60ies, Medieval Ages, 17th century, lunch-time, weekend, etc. Those concepts
that cannot be explicitly anchored on the time line as time periods are not within the scope of the ontology,
therefore they are not included in this category. Examples of such (time period)concepts could be fuzzy
concepts as sometime in future, while ago, whenever possible, way before, etc. (All members and all
members of the sebcategories are based on Gregorian Calendar )</rdfs:comment>
```

```
</owl:Class>
```

```
<!--Class Islamic Time Periods -->
```

```
<owl:Class rdf:ID="IslamicTimePeriodsWithDurationOfLongerThanOneDay">
```

```
<rdfs:subClassOf>
```

```
<owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfLongerThanOneDay"/>
```

```
</rdfs:subClassOf>
```

```
</owl:Class>
```

```
<!--Class USAmerican Time Periods with Duartion of Longer than One Day -->
```

```
<owl:Class rdf:ID="USAmericanTimePeriodsWithDurationOfLongerThanOneDay">
```

```
<rdfs:subClassOf>
```

```

    <owl:Class rdf:about="#SocioculturalTimePeriodsOfNationsWithDurationLongerThanOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Turkish-Islamic Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="TurkishIslamicTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#IslamicSocioculturalTimePeriodsWithDurationOfOneDay"/>
        <owl:Class rdf:about="#TurkishTimePeriodsWithDurationOfOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class rdf:about="#TurkishTimePeriodsWithDurationOfOneDay"/>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class rdf:about="#IslamicSocioculturalTimePeriodsWithDurationOfOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Turkish-Islamic Time Periods with Duartion of Longer than One Day -->

```

<owl:Class rdf:ID="TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#IslamicTimeTimePeriodsWithDurationOfLongerThanOneDay"/>
        <owl:Class rdf:about="#TurkishTimePeriodsWithDurationLongerThanOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class rdf:about="#TurkishTimePeriodsWithDurationLongerThanOneDay"/>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#IslamicTimeTimePeriodsWithDurationOfLongerThanOneDay"/>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of Secondary Education with Duration of One Day -->

```

<owl:Class rdf:ID="SocioCulturalTimePeriodsOfSecondaryEducationWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfOneDay"/>
  </rdfs:subClassOf>

```

```

    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
    only related to secondary education with duration one day</rdfs:comment>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Higher Education with Duration of One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodsOfHigherEducationWithDurationOfOneDay">
    <rdfs:subClassOf>
      <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfOneDay"/>
      </rdfs:subClassOf>
      <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
      only related to higher education with duration one day</rdfs:comment>
    </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Life & Education with Duration of Longer than One Day -->

```

  <owl:Class
rdf:ID="SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationLongerThanOneDay">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
    both related to business life and education and with duration longer than one day</rdfs:comment>
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Higher Education Education with Duration of One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay">
    <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationLongerThanOneDay"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
    both related to higher education and education with duration longer than one day</rdfs:comment>
  </owl:Class>

```

<!--Class German Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="GermanTimePeriodsWithDurationShorterThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfNationsWithDurationShorterThanOneDay"/>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
        <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Life with Duration of One Day -->

```

<owl:Class rdf:ID="SocioCulturalTimePeriodsOfBusinessLifeWithDurationOfOneDay">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
only related to business life with duration one day</rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Jewish Time Periods with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="JewishTimePeriodsWithDurationShorterThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfShorterThanOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Socio-Cultural TimePeriods of Nations with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfNationsWithDurationLongerThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
  </rdfs:subClassOf>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
both related to nations and with duration longer than one day</rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">

```

```

    <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
  </owl:intersectionOf>
</owl:Class>
</rdfs:subClassOf>
</rdfs:subClassOf>
  <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
</rdfs:subClassOf>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsWithDurationOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriods"/>
  </rdfs:subClassOf>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural
time periods with a duration of one day. Any Sociococultural TimePeriod with Duration One Day is a
Sociocultural Time Period e.g. Thanksgiving Day, Day of Unity, etc.</rdfs:comment>
</owl:Class>

```

<!--Class USAmerican Time Periods of Higher Education with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay"/>
  <rdfs:subClassOf rdf:resource="#USAmericanTimePeriodsWithDurationOfLongerThanOneDay"/>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class
rdf:about="#SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay"/>
        <owl:Class rdf:about="#USAmericanTimePeriodsWithDurationOfLongerThanOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Israeli Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="IsraeliTimPeriodsWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfNationsWithDurationOfOneDay"/>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:ID="GermanTimePeriodsWithDurationLongerThanOneDay">

```

```

    <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationLongerThanOneDay"/>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods with Duration of Shorter than One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodsWithDurationShorterThanOneDay">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural
time periods with a duration of shorter than one day. Any Sociocultural Time Period with Duration Shorter
than One Day is a Sociocultural Time Period e.g Rush Hour, Happy Hour, Seminar</rdfs:comment>
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriods"/>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periodsof Secondary Education with Duration of Shorter than One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodOfSecondaryEducationWithDurationShorterThanOneDay">
    <rdfs:subClassOf>
      <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfShorterThanOneDay"/>
    </rdfs:subClassOf>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
only related to secondary education with duration shorter than one day</rdfs:comment>
  </owl:Class>

```

<!--Class Jewish Socio-Cultural time Periods with Duration of One Day -->

```

  <owl:Class rdf:ID="JewishSocioculturalTimePeriodsWithDurationOfOneDay">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay"/>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class US American Time Periods with Duration of Shorter than One Day -->

```

  <owl:Class rdf:ID="USAmericanTimePeriodsWithDurationShorterThanOneDay">
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
  </owl:Class>

```

```

</rdfs:subClassOf>
<rdfs:subClassOf>
  <owl:Class rdf:about="#SocioculturalTimePeriodsOfNationsWithDurationShorterThanOneDay"/>
</rdfs:subClassOf>
</owl:Class>

```

<!--Class Israeli Time Periods with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="IsraeliTimePeriodsWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationLongerThanOneDay"/>
  </owl:Class>
  <owl:Class
rdf:ID="SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay">
    <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationLongerThanOneDay"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
only related to secondary education with duration longer than one day</rdfs:comment>
  </owl:Class>
  <owl:Class rdf:ID="IslamicTimePeriodsWithDurationShorterThanOneDay">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfShorterThanOneDay"/>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Lifewith Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
only related to business life with duration shorter than one day e.g. Happy Hour, Rush Hour</rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfShorterThanOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of Nations -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfNations">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriods"/>
  </rdfs:subClassOf>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural
time periods that are specific to the members of a nation. e.g. Halloween, Columbus Day, Victory Day etc.
Any Sociocultural Time Period Of Nations is a Sociocultural Time Period</rdfs:comment>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of higher Education with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfHigherEducationWithDurationOfShorterThanOneDay">
  <rdfs:subClassOf>
    <owl:Class
rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfShorterThanOneDay"/>
  </rdfs:subClassOf>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
only related to higher education with duration shorter than one day</rdfs:comment>
</owl:Class>

```

<!--Class Socio-Cultural Time Periodsof Business Life and Education with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfBusinessLifeAndEducation">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural
time periods that are specific to the members of education (academia, highschools, etc.) and business life. e.g.
meeting hours, exhibitions dates, office hours, business vacation, semester, fall break, intersession, etc. Any
Sociocultural Time Period Of Business Life And Education is a Sociocultural Time Period
</rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriods"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class German-Christian Time Periods with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="GermanChristianTimePeriodsWithDurationLongerThanOneDay">
  <rdfs:subClassOf rdf:resource="#GermanTimePeriodsWithDurationLongerThanOneDay"/>
  <rdfs:subClassOf>
    <owl:Class rdf:about="#ChristianTimePeriodsWithDurationOfLongerThanOneDay"/>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#ChristianTimePeriodsWithDurationOfLongerThanOneDay"/>
        <owl:Class rdf:about="#GermanTimePeriodsWithDurationLongerThanOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods -->

```

<owl:Class rdf:ID="SocioculturalTimePeriods">

```

```
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural time periods that are specific to the members of education (academia, highschoools, etc.) and business life. e.g. meeting hours, exhibitions dates, office hours, business vacation, semester, fall break, intersession, etc. A sociocultural time period belonging to this concept should be able to answer the question of "where does sociocultural time period x come from?" Any SocioculturalTimePeriod is Time Period</rdfs:comment>
```

```
<owl:disjointWith>
  <owl:Class rdf:about="#CalendarDatePeriods"/>
</owl:disjointWith>
<rdfs:subClassOf rdf:resource="#TimePeriods"/>
</owl:Class>
```

<!--Class Socio-Cultural Time Periods of Religions -->

```
<owl:Class rdf:ID="SocioculturalTimePeriodsOfReligions">
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriods"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural time periods that are specific to the members of a religion. e.g. Easter, Passover, Ramadan, Namaz (Islamic prayer times), Iftar (time of sunset in Ramadan when the observers of Ramadan are allowed to eat), etc. Any Sociocultural Time Period Of Religions is a Sociocultural Time Period</rdfs:comment>
</owl:Class>
```

<!--Class Socio-Culturl Time Periods of Nations with Duration of Shorter than One Day -->

```
<owl:Class rdf:ID="SocioculturalTimePeriodsOfNationsWithDurationShorterThanOneDay">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
        <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfNations"/>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods both related to nations and with duration shorter than one day</rdfs:comment>
</owl:Class>
```

<!--Class German-Christian Time Periods with Duration of One Day -->

```
<owl:Class rdf:ID="GermanChristianTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#ChristianSocioculturalTimePeriodsOfOneDay"/>
        <owl:Class rdf:about="#GermanTimePeriodsWithDurationOfOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
```

```

    </owl:Class>
  </rdfs:subClassOf>
<rdfs:subClassOf>
  <owl:Class rdf:about="#ChristianSocioculturalTimePeriodsOfOneDay"/>
</rdfs:subClassOf>
<rdfs:subClassOf>
  <owl:Class rdf:about="#GermanTimePeriodsWithDurationOfOneDay"/>
</rdfs:subClassOf>
</owl:Class>

```

<!--Class Turkish Time Periods with Duration of Longer than One Day -->

```

  <owl:Class rdf:ID="TurkishTimePeriodsWithDurationLongerThanOneDay">
    <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationLongerThanOneDay"/>
  </owl:Class>
  <owl:Class rdf:ID="TurkishTimePeriodsWithDurationShorterThanOneDay">
    <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationShorterThanOneDay"/>
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class USAmerican Time Periods with Duration of One Day -->

```

  <owl:Class rdf:ID="USAmericanTimePeriodsWithDurationOfOneDay">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#SocioculturalTimePeriodsOfNationsWithDurationOfOneDay"/>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Life and Education with Duration of One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfOneDay">
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationOneDay"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
  </owl:Class>

```

```

    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationOneDay"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
  both related to business life and education and with duration one day</rdfs:comment>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of nations with Duration of One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfNationsWithDurationOfOneDay">
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationOneDay"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
  both related to nations and with duration one day e.g national holiday </rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
        <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfNations"/>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Life with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfBusinessLifeWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf
  rdf:resource="#SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationLongerThanOneDay"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
  only related to business life with duration longer than one day</rdfs:comment>
</owl:Class>

```

<!--Class Socio-Cultural Time Periods of Religions with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="SocioculturalTimePeriodsOfReligionsWithDurationOfShorterThanOneDay">
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfReligions"/>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
  both related to religions and with duration shorter than one day e.g Iftar</rdfs:comment>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
        <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligions"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>

```

```

    </owl:intersectionOf>
  </owl:Class>
</rdfs:subClassOf>
</owl:Class>

```

<!--Class Christian Time Periods with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="ChristianTimePeriodsWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfLongerThanOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Christian Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="ChristianSocioculturalTimePeriodsOfOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay"/>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Class Israeli-Jewish Time Periods with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="IsraeliJewishTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#JewishSocioculturalTimePeriodsWithDurationOfOneDay"/>
        <owl:Class rdf:about="#IsraeliTimPeriodsWithDurationOfOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#JewishSocioculturalTimePeriodsWithDurationOfOneDay"/>
  <rdfs:subClassOf rdf:resource="#IsraeliTimPeriodsWithDurationOfOneDay"/>
</owl:Class>

```

<!--Class Calendar Date Periods -->

```

<owl:Class rdf:ID="CalendarDatePeriods">
  <rdfs:subClassOf rdf:resource="#TimePeriods"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of temporal
periods that explicitly refer to a time period in a given calendar, e.g. 12.6.2004, January, Friday, 8.00 a.m-
12.00 p.m. etc. Any Calendar Date Period is a Temporal Period (Based on Gregorian
Calendar)</rdfs:comment>
  <owl:disjointWith rdf:resource="#SocioculturalTimePeriods"/>
</owl:Class>

```

<!--Class German Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="GermanTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationOfOneDay"/>
</owl:Class>
<owl:Class rdf:ID="ChristianTimePeriodsWithDurationShorterThanOneDay">
  <rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfReligionsWithDurationOfShorterThanOneDay"/>
</owl:Class>

```

<!--Class Israeli Time Periods with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="IsraeliTimePeriodsWithDurationShorterThanOneDay">
  <rdfs:subClassOf>
  <owl:Class>
    <owl:intersectionOf rdf:parseType="Collection">
      <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
      <owl:Class rdf:about="#SocioculturalTimePeriodsOfNations"/>
    </owl:intersectionOf>
  </owl:Class>
</rdfs:subClassOf>
<rdfs:subClassOf
rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationShorterThanOneDay"/>
</owl:Class>

```

<!--Class Israeli Jewish Time Periods with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#JewishTimePeriodsiWithDurationOfLongerThanOneDay"/>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#IsraeliTimePeriodsWithDurationOfLongerThanOneDay"/>
        <owl:Class rdf:about="#JewishTimePeriodsiWithDurationOfLongerThanOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#IsraeliTimePeriodsWithDurationOfLongerThanOneDay"/>
</owl:Class>

```

<!--Class Turkish-Islamic Time Periods with Duration of Shorter than One Day -->

```

<owl:Class rdf:ID="TurkishIslamicTimePeriodsWithDurationShorterThanOneDay">
  <rdfs:subClassOf rdf:resource="#TurkishTimePeriodsWithDurationShorterThanOneDay"/>
  <rdfs:subClassOf rdf:resource="#IslamicTimePeriodsWithDurationShorterThanOneDay"/>

```

```

<rdfs:subClassOf>
  <owl:Class>
    <owl:intersectionOf rdf:parseType="Collection">
      <owl:Class rdf:about="#TurkishTimePeriodsWithDurationShorterThanOneDay"/>
      <owl:Class rdf:about="#IslamicTimePeriodsWithDurationShorterThanOneDay"/>
    </owl:intersectionOf>
  </owl:Class>
</rdfs:subClassOf>
</owl:Class>

```

<!-- Class Turkish Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="TurkishTimePeriodsWithDurationOfOneDay">
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfNationsWithDurationOfOneDay"/>
</owl:Class>
<owl:Class rdf:ID="SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
both related to religions and with duration one day</rdfs:comment>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationOneDay"/>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfReligions"/>
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligions"/>
        <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationOneDay"/>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>

```

<!--Jewish Time Periods with Duration of Longer than One Day -->

```

<owl:Class rdf:ID="JewishTimePeriodsiWithDurationOfLongerThanOneDay">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligionsWithDurationOfLongerThanOneDay"/>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:ID="SocioculturalTimePeriodsWithDurationLongerThanOneDay">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Concept of sociocultural
time periods with a duration of longer than one day. Any Sociococultural Time Period with Duration Longer
than One Day is a Sociocultural Time Period e.g. Ramadan, Easter</rdfs:comment>
  <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriods"/>
</owl:Class>

```

<!-- Class Islamic Time Periods with Duration of One Day -->

```

<owl:Class rdf:ID="IslamicTimePeriodsWithDurationOfOneDay">

```

```

    <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay"/>
  </owl:Class>
  <owl:Class rdf:ID="IsraeliJewishTimePeriodsWithDurationShorterThanOneDay">
    <rdfs:subClassOf rdf:resource="#IsraeliTimePeriodsWithDurationShorterThanOneDay"/>
    <rdfs:subClassOf rdf:resource="#JewishTimePeriodsWithDurationShorterThanOneDay"/>
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#JewishTimePeriodsWithDurationShorterThanOneDay"/>
          <owl:Class rdf:about="#IsraeliTimePeriodsWithDurationShorterThanOneDay"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Religion with Duration of Longer than One Day -->

```

  <owl:Class rdf:ID="SocioculturalTimePeriodsOfReligionsWithDurationOfLongerThanOneDay">
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfReligions"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>
    <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationLongerThanOneDay"/>
    <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfReligions"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
    both related to religions and with duration longer than one day</rdfs:comment>
  </owl:Class>

```

<!--Class Socio-Cultural Time Periods of Business Life and Education with Duration of Shorter than One Day -->

```

  <owl:Class
  rdf:ID="SocioculturalTimePeriodsOfBusinessLifeAndEducationWithDurationOfShorterThanOneDay">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">socio-cultural time periods
    both related to business life and education and with duration shorter than one day</rdfs:comment>
    <rdfs:subClassOf>
      <owl:Class>
        <owl:intersectionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
          <owl:Class rdf:about="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
        </owl:intersectionOf>
      </owl:Class>
    </rdfs:subClassOf>

```

```

    <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsWithDurationShorterThanOneDay"/>
    <rdfs:subClassOf rdf:resource="#SocioculturalTimePeriodsOfBusinessLifeAndEducation"/>
  </owl:Class>

```

<!-------PROPERTIES----->

<!--Object property hasSuperordinate Concept -->

```

  <owl:ObjectProperty rdf:ID="hasSuperordinateConcept">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Inverse property of the
property hasSubordinateConcept</rdfs:comment>
    <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
    <owl:inverseOf>
      <owl:TransitiveProperty rdf:about="#hasSubordinateConcept"/>
    </owl:inverseOf>
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#TransitiveProperty"/>
    <rdfs:range rdf:resource="#SocioculturalTimePeriods"/>
  </owl:ObjectProperty>

```

<!--Datatype property hasSimilar Concept -->

```

  <owl:DatatypeProperty rdf:ID="hasSimilarConcept">
    <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A semantic relation of the
form: SocioculturalTimePeriods hasSimilarMeaning "STRING" e.g Carnival similarConcept "Mardi Gras".
Domain: Sociocultural TemporalPeriods Range: RDF Literal (string) Purpose is to capture similarity between
concepts</rdfs:comment>
    <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  </owl:DatatypeProperty>

```

<!--Datatype property hasIndex Concept -->

```

  <owl:DatatypeProperty rdf:ID="hasIndex">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">when is one socio-cultural
time period on the timeline? e.g. Halloween is on the 31st of october</rdfs:comment>
    <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
    <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  </owl:DatatypeProperty>
  <owl:DatatypeProperty rdf:ID="recurrence">
    <rdfs:range>
      <owl:DataRange>
        <owl:oneOf rdf:parseType="Resource">
          <rdf:rest rdf:parseType="Resource">
            <rdf:rest rdf:parseType="Resource">
              <rdf:rest rdf:parseType="Resource">

```

```

<rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#string">yearly</rdf:first>
<rdf:rest rdf:parseType="Resource">
  <rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#string">weekly</rdf:first>
  <rdf:rest rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#nil"/>
</rdf:rest>
</rdf:rest>
<rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#string">monthly</rdf:first>
</rdf:rest>
<rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#string">daily</rdf:first>
</rdf:rest>
<rdf:first rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hourly</rdf:first>
</owl:oneOf>
</owl:DataRange>
</rdfs:range>
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">how often does one time
period occur?it takes a fixed value as object value i.e. possible answers are restricted. These are: hourly, daily,
weekly, monthly and yearly</rdfs:comment>
<rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
</owl:DatatypeProperty>

```

<!--Datatype property implies General Suspension of Classes Concept -->

```

<owl:DatatypeProperty rdf:ID="impliesGeneralSuspensionOfClasses">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A property that takes a
boolean value as its value and that is of the form: SocioculturalTimePeriods generalSuspensionOfClasses
TRUE/FALSE e.g. SemesterBreak generalSuspensionOfClasses TRUE Domain: SocioculturalTimePeriods
Range:RDFLiteral (Boolean) Purpose is to explicitly demonstrate time periods that are associated with a
change in the usual flow of education life (i.e. periods of time when there is no teaching and no classes are
held)</rdfs:comment>
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#boolean"/>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#FunctionalProperty"/>
</owl:DatatypeProperty>

```

<!--Datatype property has Granularity -->

```

<owl:DatatypeProperty rdf:ID="hasGranularity">
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">what is the time unit of one
socio-cultural time period? hour, day, month, week, year etc.</rdfs:comment>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
</owl:DatatypeProperty>

```

<!--Datatype property has Duration -->

```

<owl:DatatypeProperty rdf:ID="hasDuration">

```

```

<rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
<rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">how long is one socio-
cultural time period?one day, two weeks, one year etc.</rdfs:comment>
</owl:DatatypeProperty>

```

<!--Datatype property implies General Suspension of Work -->

```

<owl:DatatypeProperty rdf:ID="impliesGeneralSuspensionOfWork">
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#boolean"/>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#FunctionalProperty"/>
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A property that takes a
boolean value as its value and that is of the of the form: SocioculturalTimePeriods generalSuspensionOfWork
TRUE/FALSE e.g. St.PatricksDay generalSuspensionOfWork FALSE Domain: SocioculturalTimePeriods
Range:RDFLiteral (Boolean)Purpose is to explicitly demonstrate time periods that are associated with a
change in the usual flow of social life (i.e. periods of time when people dont work)</rdfs:comment>
</owl:DatatypeProperty>

```

<!--Object property hasSubordinate Concept is a transitive property -->

```

<owl:TransitiveProperty rdf:ID="hasSubordinateConcept">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A (semantic relation)
property of the form:Sociocultural Time Period has Subordinate Concept Sociocultural Time Period e.g.
Holiday has Subordinate Concept Christmas Day Domain: Sociocultural Time Periods Range: Sociocultural
Time Periods Inverse:has Superordinate Concept Purpose is to capture such relations as which time period
necessarily implies another time period.</rdfs:comment>
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <owl:inverseOf rdf:resource="#hasSuperordinateConcept"/>
  <rdfs:range rdf:resource="#SocioculturalTimePeriods"/>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
</owl:TransitiveProperty>

```

<!--Datatype property has variable calendar date is a functional property -->

```

<owl:FunctionalProperty rdf:ID="hasVariableCalendarDate">
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A property that takes an
instance from class (domain) Socio-Cultural Time Periods as subject and a boolean as its value (object).It is
of the form: Socio-cultural Time Periods has Fixed Calendar Date TRUE/FALSE e.g. Easter Monday has
VariableCalendar Date TRUE Domain: Sociocultural Time Periods Range: RDFLiteral (Boolean) Purpose is
to explicitly demonstrate sociocultural concepts of time periods which cannot be anchored to the same
fraction of the timeline.</rdfs:comment>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#boolean"/>
</owl:FunctionalProperty>

```

<!--Datatype property has Fixed Calendar date is a functional property -->

```

<owl:FunctionalProperty rdf:ID="hasFixedCalendarDate">
  <rdfs:domain rdf:resource="#SocioculturalTimePeriods"/>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A property that takes an
instance from class (domain) Socio-Cultural Time Periods as subject and a boolean as its value (object).It is
of the form:SocioculturalTimePeriods has Fixed Calendar Date TRUE/FALSE e.g. St.Valentines Day has
Fixed Calendar Date TRUE Domain: Sociocultural Time Periods Range: RDFLiteral (Boolean) Purpose is to
explicitly demonstrate sociocultural concepts of time periods which can always be anchored to the same
fraction of the timeline.</rdfs:comment>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#boolean"/>
</owl:FunctionalProperty>

```

<!-------INSTANCES----->

```

<IsraeliJewishTimePeriodsWithDurationOfOneDay rdf:ID="purim">
  <hasSimilarConcept
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">fasching</hasSimilarConcept
  >
  <hasSimilarConcept
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">halloween</hasSimilarConce
    pt>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">in hebrew month Adar.
    march acc.
    to gregorian calendar</hasIndex>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <impliesGeneralSuspensionOfWork
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true
  </impliesGeneralSuspensionOfWork>
  <impliesGeneralSuspensionOfClasses
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true
  </impliesGeneralSuspensionOfClasses>
  <recurrence>yearly</recurrence>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasVariableCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendar
    Date>
</IsraeliJewishTimePeriodsWithDurationOfOneDay>

```

```

<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
rdf:ID="summerSemester">
  <hasSuperordinateConcept>
    <SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
      rdf:ID="academicTrimester">
  </hasSuperordinateConcept>

```

```

    <SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
      rdf:ID="academicYear">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8 months</hasDuration>
    <hasVariableCalendarDate
      rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendar
      Date>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">month</hasGranularity>
    <recurrence>yearly</recurrence>
    <hasSubordinateConcept rdf:resource="#academicTrimester"/>
    <hasSubordinateConcept>
    <SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
      rdf:ID="academicSemester">
    <hasSuperordinateConcept rdf:resource="#academicYear"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
      rdf:ID="fallSemester">
    <hasSuperordinateConcept rdf:resource="#academicSemester"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">weeks</hasGranularity>
    <recurrence>yearly</recurrence>
    <hasVariableCalendarDate
      rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendar
      Date>
    <hasSuperordinateConcept rdf:resource="#academicTrimester"/>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
      rdf:ID="midTerms">
    <impliesGeneralSuspensionOfClasses
      rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true
    </impliesGeneralSuspensionOfClasses>
    <hasSuperordinateConcept rdf:resource="#fallSemester"/>
    <recurrence>yearly</recurrence>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a week reserved for final
      examination at the university at the end of the first academic semster of the academicc
      year</rdfs:comment>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last week of the first academic
      semester of an academic year</hasIndex>
    <hasGranularity
      rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 week</hasDuration>
    <hasVariableCalendarDate
      rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendar
      Date>
  </USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
  </hasSubordinateConcept>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">18
    weeks</hasDuration>
  </USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
  </hasSubordinateConcept>

```

```

<hasVariableCalendarDate
  rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendar
  Date>
<hasSubordinateConcept>
<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
  rdf:ID="springSemester">
<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">18
  weeks</hasDuration>
<hasSubordinateConcept>

<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay rdf:ID="finalsWeek">
  <hasVariableCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariable
    CalendarDate><rdfs:comment
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a week reserved for final
    examinations at the university at the end of the last academic semster of the academic
    year</rdfs:comment>
  <recurrence>yearly</recurrence>
  <hasSuperordinateConcept rdf:resource="#springSemester"/>
  <hasGranularity
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularit
    y>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last week of the
  last academic semester of an academic year</hasIndex>
  <impliesGeneralSuspensionOfClasses
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGene
    ralSuspensionOfClasses>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1
  week</hasDuration>
</USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
</hasSubordinateConcept>
<hasSuperordinateConcept rdf:resource="#academicSemester"/>
<hasSuperordinateConcept rdf:resource="#academicTrimester"/>
<hasGranularity
  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularit
  y>
  <recurrence>yearly</recurrence>
</USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
</hasSubordinateConcept>
<hasSimilarConcept
  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">academicTerm</has
  SimilarConcept>
<recurrence>yearly</recurrence>
<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">18
  weeks</hasDuration>
  <hasSimilarConcept
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">academic
    session</hasSimilarConcept>
</SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

```

```

    </hasSubordinateConcept>
</SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
  </hasSuperordinateConcept>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <hasSubordinateConcept rdf:resource="#summerSemester"/>
  <recurrence>yearly</recurrence>
  <hasSubordinateConcept rdf:resource="#fallSemester"/>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one of three terms into
which the academic year is sometimes divided </rdfs:comment>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
  <hasSubordinateConcept rdf:resource="#springSemester"/>
</SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>
  </hasSuperordinateConcept>
</USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

<TurkishTimePeriodsWithDurationOfOneDay rdf:ID="nationalSovereigntyAndChildrensDay">
  <recurrence>yearly</recurrence>
  <hasFixedCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasSuperordinateConcept>
  <SocioculturalTimePeriodsWithDurationOneDay rdf:ID="holiday">
  <hasSubordinateConcept>
  <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="presidentsDay">
  <recurrence>yearly</recurrence>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasSuperordinateConcept rdf:resource="#holiday"/>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">third Monday in
february</hasIndex>
  </USAmericanTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="epiphany">
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasVariableCalendarDate>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>

```

```

    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <recurrence>yearly</recurrence>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">january 6th</hasIndex>
      </ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="stPatricksDay">
      <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
      <recurrence>yearly</recurrence>
      <hasSuperordinateConcept rdf:resource="#holiday"/>
      <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">17th march</hasIndex>
      <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
      <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
        </ChristianSocioculturalTimePeriodsOfOneDay>
      </hasSubordinateConcept>
      <hasSubordinateConcept>
      <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="halloween">
        <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
        <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
          <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
          <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">31th october</hasIndex>
          <hasSuperordinateConcept rdf:resource="#holiday"/>
          <recurrence>yearly</recurrence>
        </USAmericanTimePeriodsWithDurationOfOneDay>
        </hasSubordinateConcept>
        <hasSubordinateConcept>
        <GermanChristianTimePeriodsWithDurationOfOneDay rdf:ID="sundayOfTheDead">
          <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last sunday before
advent</hasIndex>
          <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
          <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
            <recurrence>yearly</recurrence>
            <hasSuperordinateConcept rdf:resource="#holiday"/>
            <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
              <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
              <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
                </GermanChristianTimePeriodsWithDurationOfOneDay>
              </hasSubordinateConcept>
              <hasSubordinateConcept>
              <GermanChristianTimePeriodsWithDurationOfOneDay rdf:ID="ernteDankTag">
                <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>

```

```

    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">german
    thanksgiving day</hasSimilarConcept>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1st sunday in
    october</hasIndex>
    <impliesGeneralSuspensionOfWork
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasVariableCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    </GermanChristianTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="allSaintsDay">
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1st november </hasIndex>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <impliesGeneralSuspensionOfWork
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasFixedCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <impliesGeneralSuspensionOfClasses
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    </ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="easterMonday">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">monday after good
    friday</hasIndex>
    <impliesGeneralSuspensionOfWork
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasVariableCalendarDate
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
    <hasSuperordinateConcept>
    <ChristianTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="easter">
    <impliesGeneralSuspensionOfClasses
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">time period that covers
    good friday to easter monday</rdfs:comment>
    <impliesGeneralSuspensionOfWork
    rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>

```

```

<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">4 days</hasDuration>
<hasSubordinateConcept>

      <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="goodFriday">
<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
<hasSuperordinateConcept rdf:resource="#easter"/>
<recurrence>yearly</recurrence>
<hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">friday before easter
monday</hasIndex>

      </ChristianSocioculturalTimePeriodsOfOneDay>
</hasSubordinateConcept>
<hasSubordinateConcept rdf:resource="#easterMonday"/>
<hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</ChristianTimePeriodsWithDurationOfLongerThanOneDay>
</hasSuperordinateConcept>
<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
<hasSuperordinateConcept rdf:resource="#holiday"/>
<impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
</ChristianSocioculturalTimePeriodsOfOneDay>
  </hasSubordinateConcept>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasSubordinateConcept>
<GermanTimePeriodsWithDurationOfOneDay rdf:ID="reformationDay">
  <hasSuperordinateConcept rdf:resource="#holiday"/>
  <recurrence>yearly</recurrence>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">october 31</hasIndex>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
</GermanTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
<ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="ascencion">
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasSuperordinateConcept rdf:resource="#holiday"/>

```

```

    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">40 days after
easter</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <GermanTimePeriodsWithDurationOfOneDay rdf:ID="mayDay">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">may 1</hasIndex>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">workers
day</hasSimilarConcept>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one day</hasDuration>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">spring
day</hasSimilarConcept>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    </GermanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <GermanChristianTimePeriodsWithDurationOfOneDay rdf:ID="faschingsDienstag">
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">fat
tuesday</hasSimilarConcept>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day before Ash Wednesday,
Tuesday during the Karneval week</hasIndex>
    <hasSuperordinateConcept>
    <GermanChristianTimePeriodsWithDurationLongerThanOneDay rdf:ID="karneval">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">starts 6 days before ash
wednesday</hasIndex>
    <recurrence>yearly</recurrence>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">German week of
festivities for which includes the day Carnival</rdfs:comment>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">6 days</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSubordinateConcept rdf:resource="#faschingsDienstag"/>
</GermanChristianTimePeriodsWithDurationLongerThanOneDay>
    </hasSuperordinateConcept>

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    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">carnival</hasSimilarConcept>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">mardi
gras</hasSimilarConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">shrove
tuesday</hasSimilarConcept>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    </GermanChristianTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept> <IsraeliJewishTimePeriodsWithDurationOfOneDay
rdf:ID="simkatTorah">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">in Tihri in hebrew calendar.
app. in october acc. to gregorian calendar</hasIndex>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">reading of of
Torah</hasSimilarConcept>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    </IsraeliJewishTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <IsraeliJewishTimePeriodsWithDurationOfOneDay rdf:ID="yomKippur">
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">10th of Tishri acc. to hebrew
calendar. late september early october</hasIndex>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Jewish Day of
Atonement </hasSimilarConcept>
    </IsraeliJewishTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>

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<USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="thanksgivingDay">
  <hasSuperordinateConcept rdf:resource="#holiday"/>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">fourth Thursday in
November</hasIndex>
  <recurrence>yearly</recurrence>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasGranularity>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
</USAmericanTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="ashWednesday">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">beginning of
lent</rdfs:comment>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">40 days before
easter</hasIndex>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <hasSuperordinateConcept rdf:resource="#holiday"/>
  <recurrence>yearly</recurrence>
</ChristianSocioculturalTimePeriodsOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <TurkishTimePeriodsWithDurationOfOneDay rdf:ID="victoryDay">
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">30th august</hasIndex>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
  <recurrence>yearly</recurrence>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasSuperordinateConcept rdf:resource="#holiday"/>
</TurkishTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <TurkishTimePeriodsWithDurationOfOneDay rdf:ID="atatuerkYOUTHCommemorationSportsDay">
  <recurrence>yearly</recurrence>
  <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>

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    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">19th may</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</impliesGeneralSuspensionOfWork>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasVariableCalendarDate>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</TurkishTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="palmSunday">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last sunday before
easter</hasIndex>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
</ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="veteransDay">
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">on 11th of
november</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one day</hasDuration>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">armistice
day</hasSimilarConcept>
</USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="columbusDay">

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    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">discovery of the
american continent</hasSimilarConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">second Moday in
October</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one Day</hasDuration>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    </USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <GermanChristianTimePeriodsWithDurationOfOneDay rdf:ID="martinsDay">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">11.11 at 11.00
am</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">beginning of Karneval
preparations</rdfs:comment>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    </GermanChristianTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="memorialDay">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last monday in
May</hasIndex>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one day</hasDuration>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    </USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="pentecost">
    <recurrence>yearly</recurrence>

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    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">whitsunday</hasSimilarConcept>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">50 days after
easter</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <GermanTimePeriodsWithDurationOfOneDay rdf:ID="sylvester">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">31st december</hasIndex>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</impliesGeneralSuspensionOfWork>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">new years
eve</hasSimilarConcept>
</GermanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="stValentinesDay">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">14th of february</hasIndex>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
</ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept rdf:resource="#nationalSovereigntyAndChildrensDay"/>
    <hasSubordinateConcept>
    <IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="hanukkah">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">begins 25th of jewish month
Kislev (corresponds to November and December)</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8 days</hasDuration>

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    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">festival of
lights</hasSimilarConcept>
    <recurrence>yearly</recurrence>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
</IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
<GermanChristianTimePeriodsWithDurationOfOneDay rdf:ID="roseMonday">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">monday before carnival
tuesday</rdfs:comment>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">monday before carnival or fat
tuesday or mardi gras</hasIndex>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
</GermanChristianTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
<ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="adventSunday">
    <hasSuperordinateConcept>
<ChristianTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="advent">
    <recurrence>yearly</recurrence>
    <hasSubordinateConcept rdf:resource="#adventSunday"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">4 sundays before
christmas</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">4 sundays</hasDuration>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the period beginning
four Sundays before Christmas and observed by some Christians </rdfs:comment>
</ChristianTimePeriodsWithDurationOfLongerThanOneDay>
    </hasSuperordinateConcept>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>

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    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1st sunday in
advent</hasIndex>
  </ChristianSocioculturalTimePeriodsOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="whitMonday">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">7 weeks after easter
monday</rdfs:comment>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <recurrence>yearly</recurrence>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">7 weeks after easter
monday</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  </ChristianSocioculturalTimePeriodsOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <IsraeliJewishTimePeriodsWithDurationOfOneDay rdf:ID="shavuot">
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">50 days after
pesach</hasIndex>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">pentecost</hasSimilarConcept>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  </IsraeliJewishTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <hasSubordinateConcept>
  <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="laborDay">
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">first Monday in
September</hasIndex>

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    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one day</hasDuration>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">marks the end of
summer holidays and the beginning of classes or work </rdfs:comment>
  </USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="christmasDay">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">25th december</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasSuperordinateConcept>
    <ChristianTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="christmas">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">25th 26th 27th
december</hasIndex>
    <recurrence>yearly</recurrence>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasVariableCalendarDate>
    <hasSubordinateConcept rdf:resource="#christmasDay"/>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasSuperordinateConcept>
    <ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="stStephensDay">
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">boxing
day</hasSimilarConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">second christmas
day</hasSimilarConcept>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">first weekday after
Christmas</rdfs:comment>
    <hasSubordinateConcept rdf:resource="#christmas"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">26th december</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  </ChristianSocioculturalTimePeriodsOfOneDay>

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    </hasSuperordinateConcept>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 days</hasDuration>
  </ChristianTimePeriodsWithDurationOfLongerThanOneDay>
    </hasSuperordinateConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  </ChristianSocioculturalTimePeriodsOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="martinLutherKingsBirthday">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">third Monday in
January</hasIndex>
    <hasSuperordinateConcept rdf:resource="#holiday"/>
  </USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
  </SocioculturalTimePeriodsWithDurationOneDay>
    </hasSuperordinateConcept>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">23rd april</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  </TurkishTimePeriodsWithDurationOfOneDay>

  <SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay
rdf:ID="schoolTerm">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">5 months</hasDuration>
    <hasSuperordinateConcept>
    <SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay
rdf:ID="schoolYear">
    <recurrence>yearly</recurrence>
    <hasGranularity
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">month</hasGranularity>

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    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">10
months</hasDuration>
    <hasSubordinateConcept rdf:resource="#schoolTerm"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the period of time each
year when the high school is open and high school students are people are studying</rdfs:comment>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">starts
september</hasIndex>
    </SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay>
    </hasSuperordinateConcept>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">september</hasIndex>
    <hasGranularity
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">months</hasGranularity>
    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">schoolSemester</hasSimilarConcept>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    </SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay>

    <USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
rdf:ID="springBreak">
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">in march</hasIndex>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a week of recess
during the spring term at university</rdfs:comment>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 week</hasDuration>
    <hasGranularity
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    </USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

    <CalendarDatePeriods rdf:ID="march_30">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">simple date
entry</rdfs:comment>
    </CalendarDatePeriods>

    <GermanTimePeriodsWithDurationLongerThanOneDay rdf:ID="germanWeekend">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Saturday,
Sunday</hasIndex>
    <recurrence>weekly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
    </GermanTimePeriodsWithDurationLongerThanOneDay>
    <CalendarDatePeriods rdf:ID="_2005">

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    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">simple date
entry</rdfs:comment>
  </CalendarDatePeriods>

  <CalendarDatePeriods rdf:ID="january_12_2004"/>

    <ChristianTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="lent">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">40 days</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">begins with ash wednesday
40 days before easter</hasIndex>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">beginning of
fasting</rdfs:comment>
    <recurrence>yearly</recurrence>
  </ChristianTimePeriodsWithDurationOfLongerThanOneDay>

    <SocioculturalTimePeriodsOfNationsWithDurationOfOneDay rdf:ID="nationalHoliday">
    <hasSubordinateConcept>
    <USAmericanTimePeriodsWithDurationOfOneDay rdf:ID="July4th">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">independence
day</hasSimilarConcept>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one day</hasDuration>
    <hasSuperordinateConcept rdf:resource="#nationalHoliday"/>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">fourth of July</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    </USAmericanTimePeriodsWithDurationOfOneDay>
    </hasSubordinateConcept>
    <hasSubordinateConcept>
    <TurkishTimePeriodsWithDurationOfOneDay rdf:ID="republicDay">
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">29th october</hasIndex>
    <hasSuperordinateConcept rdf:resource="#nationalHoliday"/>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>

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</TurkishTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  </hasSubordinateConcept>
  <GermanTimePeriodsWithDurationOfOneDay rdf:ID="dayOfUnity">
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">october 3</hasIndex>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">tag der
Einheit</hasSimilarConcept>
    <hasSuperordinateConcept rdf:resource="#nationalHoliday"/>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">unification of
Germany</hasSimilarConcept>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  </GermanTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasFixedCalendarDate>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a specific kind of holiday
related to a nation during which holidays banks and schools are closed, mail is not delivered and some
businesses are closed.</rdfs:comment>
  </SocioculturalTimePeriodsOfNationsWithDurationOfOneDay>

  <GermanTimePeriodsWithDurationLongerThanOneDay rdf:ID="oktoberfest">
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">16 days</hasDuration>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasFixedCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">third saturday in
september</hasIndex>
    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">wiesn</hasSimilarConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  </GermanTimePeriodsWithDurationLongerThanOneDay>

  <SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay rdf:ID="rushHour">

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    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hour</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 hours</hasDuration>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasFixedCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1st to 5th days of the week
between 6.00 pm-8.00 pm</hasIndex>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1st to 5th days of the week
between 8.00 am -10.00 am</hasIndex>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the times at the
beginning and end of the working day when many people are traveling to or from wo</rdfs:comment>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</hasVariableCalendarDate>
    </SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay>

    <SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay
rdf:ID="halfTerm">
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">between two high school
terms</hasIndex>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</impliesGeneralSuspensionOfClasses>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">half term
vacation</hasSimilarConcept>
    </SocioculturalTimePeriodsOfSecondaryEducationWithDurationOfLongerThanOneDay>

    <SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay rdf:ID="happyHour">
    <recurrence>daily</recurrence>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hour</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 hours</hasDuration>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</hasFixedCalendarDate>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasVariableCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">11 pm to 1 am</hasIndex>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">5 pm to 8 pm</hasIndex>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"> a period of time during
which the price of drinks (as at a bar) is reduced or hors doeuvres are served free </rdfs:comment>
    </SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay>

<TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="feastOfTheSacrifice">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 days</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">10th day of the 12th last mionth
of the islamic calendar</hasIndex>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</impliesGeneralSuspensionOfClasses>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <recurrence>yearly</recurrence>

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    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
</TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay>
<TurkishTimePeriodsWithDurationLongerThanOneDay rdf:ID="turkishWeekend">
    <recurrence>weekly</recurrence>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Saturday, Sunday</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
</TurkishTimePeriodsWithDurationLongerThanOneDay>
<IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="pessah">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">app. a week</hasDuration>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">passover</hasSimilarConcept>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">app. in april</hasIndex>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    <recurrence>yearly</recurrence>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay>
<IsraeliTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="israeliWeekend">
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasFixedCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Friday, Saturday</hasIndex>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
    <recurrence>weekly</recurrence>
</IsraeliTimePeriodsWithDurationOfLongerThanOneDay>
<CalendarDatePeriods rdf:ID="february">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">simple date
entry</rdfs:comment>
</CalendarDatePeriods>
    <SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay rdf:ID="nightShift">
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">night shift - the work shift
during the night (as midnight to 8 a.m.)</rdfs:comment>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hour</hasGranularity>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8 hours</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">at 12.00 midnight</hasIndex>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasVariableCalendarDate>
</SocioculturalTimePeriodsOfBusinessLifeWithDurationShorterThanOneDay>
<TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="ramadan">

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    <recurrence>yearly</recurrence>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the 9th month of the
Islamic year observed as sacred with fasting practiced daily from dawn to sunset </rdfs:comment>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1onth</hasDuration>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the 9th month of the Islamic
year</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">month</hasGranularity>
</TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay>
    <SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
rdf:ID="semesterBreak">
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">term
break</hasSimilarConcept>
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8 weeks</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">between two academic
semesters</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
</SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay rdf:ID="fallBreak">
    <recurrence>yearly</recurrence>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 days</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">in october</hasIndex>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 days of recess during the
spring term at university</rdfs:comment>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
</USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

<CalendarDatePeriods rdf:ID="a.m.8.00">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">simple date
entry</rdfs:comment>
</CalendarDatePeriods>

<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay rdf:ID="usAmericanWeekend">
    <recurrence>yearly</recurrence>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">saturday, sunday</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
</USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

```

```

<TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="feastOfSugar">
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">festival of fast
breaking</hasSimilarConcept>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">feast at the end of
ramadan</rdfs:comment>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">end of ramadan</hasIndex>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 days</hasDuration>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <recurrence>yearly</recurrence>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string"/>
</TurkishIslamicTimePeriodsWithDurationOfLongerThanOneDay>

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<IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="sukkot">
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <recurrence>yearly</recurrence>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">late september
oktober</hasIndex>
</IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay>

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<TurkishIslamicTimePeriodsWithDurationShorterThanOneDay rdf:ID="iftar">
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">after sunset</hasIndex>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 month during
ramadan</hasDuration>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <recurrence>daily</recurrence>
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hour</hasGranularity>
</TurkishIslamicTimePeriodsWithDurationShorterThanOneDay>

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<SocioculturalTimePeriodsWithDurationLongerThanOneDay rdf:ID="weekend">

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    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">sixth and seventh day of the
week</hasIndex>
  </SocioculturalTimePeriodsWithDurationLongerThanOneDay>

<ChristianSocioculturalTimePeriodsOfOneDay rdf:ID="sunday">
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">7th day of the week</hasIndex>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <recurrence>weekly</recurrence>
  <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
  <hasSuperordinateConcept>
    <SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay rdf:ID="holyDay">
      <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
      <hasSubordinateConcept rdf:resource="#sunday"/>
    </SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay>
    <TurkishIslamicTimePeriodsWithDurationOfOneDay rdf:ID="juma">
      <hasGranularity
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
      <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
      <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1
day</hasDuration>
      <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
      <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">religious
day</hasSimilarConcept>
      <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day of
rest</hasSimilarConcept>
      <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasFixedCalendarDate>
      <hasSuperordinateConcept rdf:resource="#holyDay"/>
      <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">5th day of the
week</hasIndex>
      <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">friday</hasSimilarConcept>
      <recurrence>weekly</recurrence>
      <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">turkis islamic holy
day, religious day of the week, day of rest</rdfs:comment>
    </TurkishIslamicTimePeriodsWithDurationOfOneDay>
  </hasSubordinateConcept>
  <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
  <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasFixedCalendarDate>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 day</hasDuration>

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    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">5th or 6th or 7th day of the
week</hasIndex>
    <recurrence>weekly</recurrence>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the holy day of a given
religion</rdfs:comment>
    <hasSubordinateConcept>
      <IsraeliJewishTimePeriodsWithDurationOfOneDay rdf:ID="sabbath">
        <hasSimilarConcept
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">saturday</hasSimilarConcept>
        <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>false</hasFixedCalendarDate>
        <hasGranularity
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
        <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</impliesGeneralSuspensionOfWork>
        <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day of
rest</hasSimilarConcept>
        <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</impliesGeneralSuspensionOfClasses>
        <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">religious
day</hasSimilarConcept>
        <hasSuperordinateConcept rdf:resource="#holyDay"/>
        <recurrence>weekly</recurrence>
        <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">6th day of the
week</hasIndex>
        <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1
day</hasDuration>
        </IsraeliJewishTimePeriodsWithDurationOfOneDay>
      </hasSubordinateConcept>
      <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</impliesGeneralSuspensionOfWork>
      </SocioculturalTimePeriodsOfReligionsWithDurationOfOneDay>
    </hasSuperordinateConcept>
  </ChristianSocioculturalTimePeriodsOfOneDay>

<ChristianTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="holyWeek">
  <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">>true</hasVariableCalendarDate>
  <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">last week before easter
monday</hasIndex>
  <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 week</hasDuration>
  <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">passion
week</hasSimilarConcept>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the week before easter
monday</rdfs:comment>
  <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
</ChristianTimePeriodsWithDurationOfLongerThanOneDay>

<IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay rdf:ID="rosHashanah">

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    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasVariableCalendarDate>
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2 days</hasDuration>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">day</hasGranularity>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasFixedCalendarDate>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">new
year</hasSimilarConcept>
    <recurrence>yearly</recurrence>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">first and 2nd of hebrew month
tishri, app september</hasIndex>
    <impliesGeneralSuspensionOfWork
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfWork>
    </IsraeliJewishTimePeriodsWithDurationOfLongerThanOneDay>

<USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay rdf:ID="intersession">
    <hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3 weeks</hasDuration>
    <hasIndex rdf:datatype="http://www.w3.org/2001/XMLSchema#string">between two acedemic
semesters</hasIndex>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <impliesGeneralSuspensionOfClasses
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</impliesGeneralSuspensionOfClasses>
    <hasFixedCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</hasFixedCalendarDate>
    </USAmericanTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

<SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay
rdf:ID="summerSchool">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a school or school session
conducted in summer enabling students to accelerate progress toward a degree, to make up credits lost
through absence or failure, or to round out professional education </rdfs:comment>
    <hasVariableCalendarDate
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</hasVariableCalendarDate>
    <recurrence>yearly</recurrence>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">week</hasGranularity>
    </SocioculturalTimePeriodsOfHigherEducationWithDurationOfLongerThanOneDay>

<SocioculturalTimePeriodsOfHigherEducationWithDurationOfShorterThanOneDay rdf:ID="semesterHour">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a unit of academic credit
representing an hour of class (as lecture class) or three hours of laboratory work each week for an academic
semester </rdfs:comment>
    <hasSimilarConcept rdf:datatype="http://www.w3.org/2001/XMLSchema#string">credit
hour</hasSimilarConcept>
    <hasGranularity rdf:datatype="http://www.w3.org/2001/XMLSchema#string">hour</hasGranularity>
    <recurrence>weekly</recurrence>

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<hasDuration rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1 class hour or 3 lab
hours</hasDuration>
</SocioculturalTimePeriodsOfHigherEducationWithDurationOfShorterThanOneDay>
<SocioculturalTimePeriodsWithDurationLongerThanOneDay rdf:ID="vacation"/>
</rdf:RDF>
```

Appendix F

PROLOG Source Code of the Application of Ontology of Concepts of Socio-Cultural Time

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%A Socio-Cultural Temporal Calendar Foundation for 2004 (Gregorian Calendar)%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%granularity%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

hour(rushHour).
 hour(happyHour).
 day(stValentinesDay).
 day(halloween).
 day(octoberfest).
 day(pessah).
 day(purim).
 day(atatuerkYouthAndCommemorationDay).
 day(feastofSugar).
 day(fasching).
 day(sukkot).
 day(erntedanktag).
 day(mayDay).
 day(goodFriday).
 day(july4th_independenceDay).
 week(fallSemester).
 week(intersession).
 month(ramadan).

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%duration%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

twoHours(rushHour).
 threeHours(happyHour).
 oneDay(stValentinesDay).
 oneDay(halloween).
 oneDay(fasching).
 oneDay(atatuerkYouthAndCommemorationDay).
 oneDay(erntedanktag).
 oneDay(purim).
 oneDay(mayDay).
 oneDay(goodFriday).
 oneDay(july4th_independenceDay).
 threeDays(feastofSugar).
 sixteenDays(octoberfest).
 sixDays(pessah).
 twoDays(sukkot).

eighteenWeeks(fallSemester).
 threeWeeks(intersession).
 oneMonth(ramadan).

%%origin religions%%

christian(stValentinesDay).
 christian(ernteDankTag).
 christian(fasching).
 christian(goodFriday).
 jewish(sukkot).
 jewish(pessah).
 jewish(purim).
 islamic(feastofSugar).
 islamic(ramadan).

%%origin nations%%

usAmerican(intersession).
 usAmerican(halloween).
 usAmerican(july4th_independenceDay).
 german(octoberfest).
 german(fasching).
 german(mayDay).
 german(ernteDankTag).
 turkish(atatuerkYouthAndCommemorationDay).
 turkish(feastofSugar).
 turkish(ramadan).
 israeli(sukkot).
 israeli(pessah).
 israeli(purim).

%%origin business life and education%%

businessLife(happyHour).
 businessLife(rushHour).
 higherEducation(fallSemester).
 higherEducation(intersession).

%%calendar entries---Gregorian Calendar--2004%%

february_14(stValentinesDay).
 february_24(fasching).
 march_7(purim).
 april_06_april_12(pessah).
 april_9(goodFriday).
 may_19(atatuerkYouthAndCommemorationDay).
 july_4(july4th_independenceDay).
 august_02_august_17(intersession).

august_18_december_10(fallSemester).
 september_18_october_30(octoberfest).
 september_30_october_01(sukkot).
 october_31(halloween).
 october_03(erntedanktag).
 october_15_november_13(ramadan).
 november_14_november_16(feastofSugar).
 am8_am10(rushHour).
 pm6_pm8(rushHour).
 pm5_pm8(happyHour).
 pm11_am01(happyHour).

%% rules %%%

stValentinesDay(X) :- day(X),oneDay(X),christian(X),february_14(X).
 octoberfest(X):- day(X),sixteenDays(X),german(X),september_18_october_30(X).
 feastofSugar(X) :- day(X),threeDays(X),turkish(X),islamic(X),november_14_november_16(X).
 rushHour(X) :- hour(X),twoHours(X),businessLife(X),am8_am10(X).
 rushHour(X) :- hour(X),twoHours(X),businessLife(X),pm6_pm8(X).
 halloween(X) :- day(X),oneDay(X),usAmerican(X),october_31(X).
 pessah(X) :- day(X),sixDays(X),jewish(X),israeli(X),april_06_april_12(X).
 purim(X) :- day(X),oneDay(X),jewish(X),israeli(X),march_7(X).
 atatuerkYouthAndCommemorationDay(X) :- day(X),oneDay(X),turkish(X),may_19(X).
 fasching(X) :- day(X),oneDay(X),christian(X),german(X),february_24(X).
 sukkot(X) :- day(X),twoDays(X),jewish(X),israeli(X),september_30_october_01(X).
 erntedanktag(X) :- day(X),oneDay(X),christian(X),german(X),october_03(X).
 intersession(X) :- week(X),threeWeeks(X),usAmerican(X),higherEducation(X),august_02_august_17(X).
 fallSemester(X) :- week(X),eighteenWeeks(X),higherEducation(X),august_18_december_10(X).
 ramadan(X):- month(X),oneMonth(X),islamic(X),turkish(X),october_15_november_13(X).
 happyHour(X) :- hour(X),threeHours(X),businessLife(X),pm5_pm8(X).
 happyHour(X):- hour(X),threeHours(X),businessLife(X),pm11_am01(X).
 july4th_independenceDay(X):- day(X),oneDay(X),usAmerican(X),july_4(X).
 goodFriday(X):- day(X),oneDay(X),christian(X),april_9(X).